## **EXHIBIT J**

## Exhibit A-28 Invalidity Claim Chart for U.S. Patent No. 7,924,802 vs. U.S. Patent No. 6,952,454

U.S. Patent No. 6,952,454 ("Jalali") was filed on July 12, 2020 and issued on October 4, 2005. Jalali anticipates asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of U.S. Patent No. 7,924,802 ("the '802 Patent") under 35 U.S.C. § 102. Jalali also renders obvious asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of the '802 Patent under 35 U.S.C. § 103, alone based on the state of the art and/or in combination with one or more other references identified in Exs. A-1–A-31, Cover Pleading, and First Supplemental Ex. A-Obviousness Chart.<sup>1</sup>

To the extent Plaintiff alleges that Jalali does not disclose any particular limitation of the asserted claims in the '802 Patent, either expressly or inherently, it would have been obvious to a person of ordinary skill in the art as of the priority date of the '802 Patent to modify Jalali and/or to combine the teachings of Jalali with other prior art references, including but not limited to the present prior art references found in Exs. A-1–A-31, Cover Pleading, First Supplemental Ex. A-Obviousness Chart, and the relevant section of charts for other prior art for the '802 Patent in a manner that would render the asserted claims of these patents invalid as obvious.

With respect to the obviousness of the asserted claims of the '802 Patent under 35 U.S.C. § 103, one or more of the principles enumerated by the United States Supreme Court in *KSR v. Teleflex*, 550 U.S. 398 (2007) apply, including: (a) combining various claimed elements known in the prior art according to known methods to yield a predictable result; and/or (b) making a simple substitution of one or more known elements for another to obtain a predictable result; and/or (c) using a known technique to improve a similar device or method in the same way; and/or (d) applying a known technique to a known device or method ready for improvement to yield a predictable result; and/or (e) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success or, in other words, the solution was one which was "obvious to try"; and/or (f) a known work in one field of endeavor prompting variations of it for use either in the same field or a different field based on given design incentives or other market forces in which the variations were predictable to one of ordinary skill in the art; and/or (g) a teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine the teachings of various prior art references to arrive at the claimed invention. It therefore would have been obvious to one of ordinary skill in the art to combine the disclosures of these references in accordance with the principles and rationales set forth ab ove.

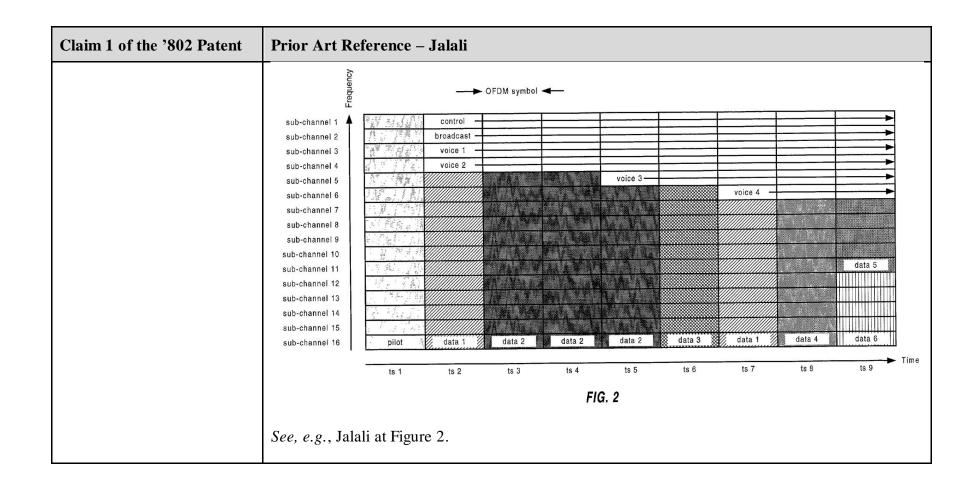
1

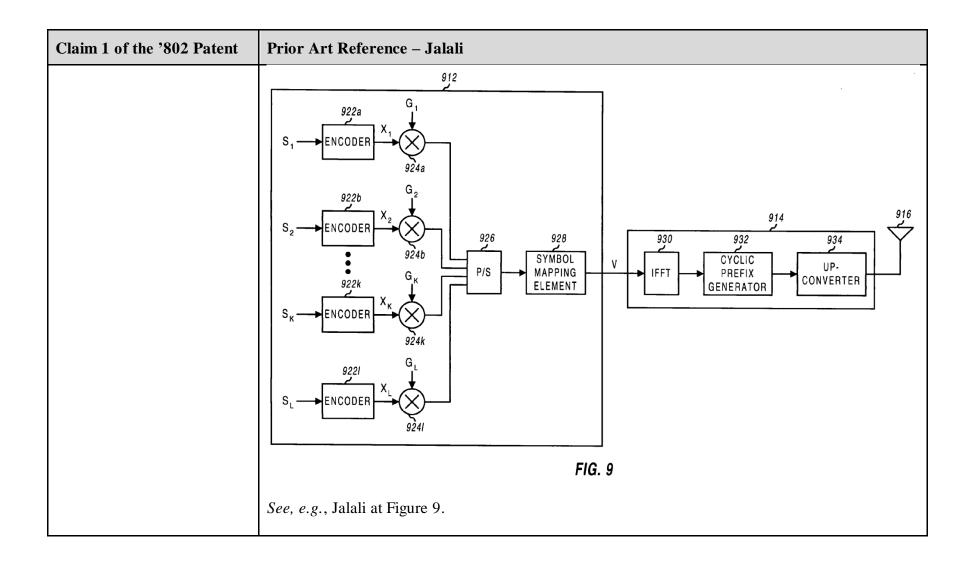
<sup>&</sup>lt;sup>1</sup> Samsung is investigating this prior art and has not yet completed discovery from third parties, who may have relevant information concerning the prior art, and therefore, Samsung reserves the right to supplement this chart after additional discovery is received. To the extent that any of the prior art discloses the same or similar functionality or feature(s) of any of the accused products, Samsung reserves the right to argue that said feature or functionality does not practice any limitation of any of the asserted claims, and to argue, in the alternative, that if said feature or functionality is found to practice any limitation of any of the asserted claims in the '802 Patent, then the prior art reference teaches the limitation and that the claim is not patentable.

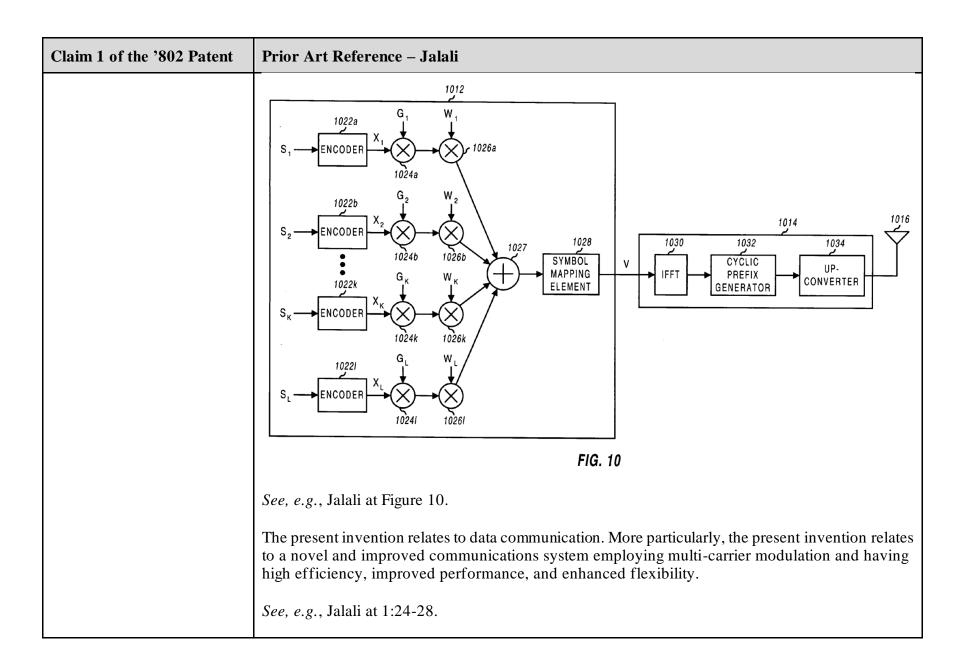
The citations to portions of any reference in this chart are exemplary only. For example, a citation that refers to or discusses a figure or figure item should be understood to also incorporate by reference that figure and any additional descriptions of that figure as if set forth fully therein. Samsung reserves the right to rely on the entirety of the references cited in this chart to show that the asserted claims of the '802 Patent are invalid. Citations presented for one claim limitation are expressly incorporated by reference into all other limitations for that claim as well as all limitations of all claims on which that claim depends. Samsung also reserves the right to rely on additional citations or sources of evidence that also may be applicable, or that may become applicable in light of claim construction, changes in Plaintiff's infringement contentions, and/or information obtained during discovery as the case progresses.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
[1.1] A method of	To the extent the preamble is limiting, Jalali discloses "A method of transmitting information in a
transmitting information in a wireless communication	wireless communication channel comprising." See, e.g.:
channel comprising:	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.  Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the
	other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.2] transmitting first information across a first frequency range using a wireless transmitter, the first	Jalali discloses "transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first highest frequency, and a first lowest frequency." See, e.g.:
frequency range having a first center frequency, a first highest frequency, and a first lowest frequency; and	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.







Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

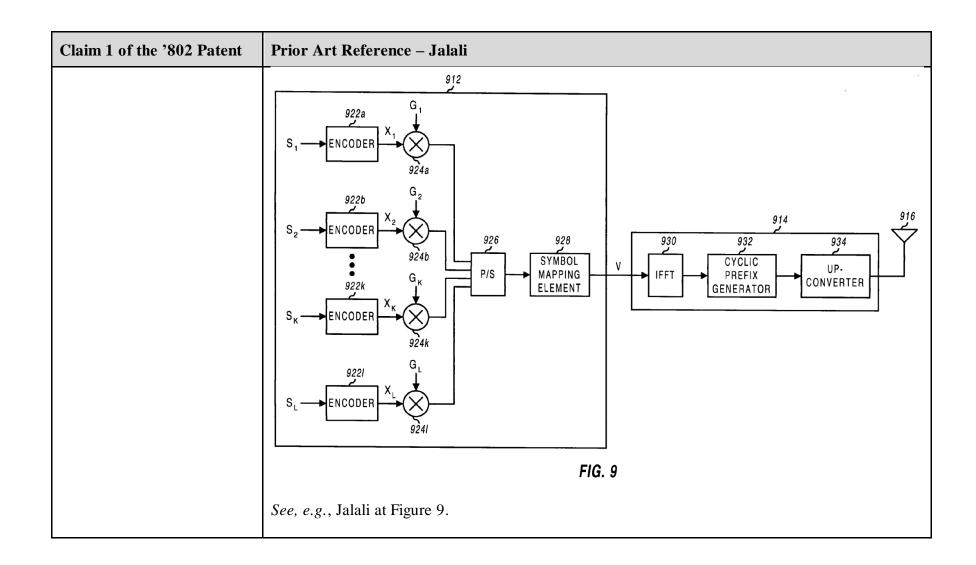
Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

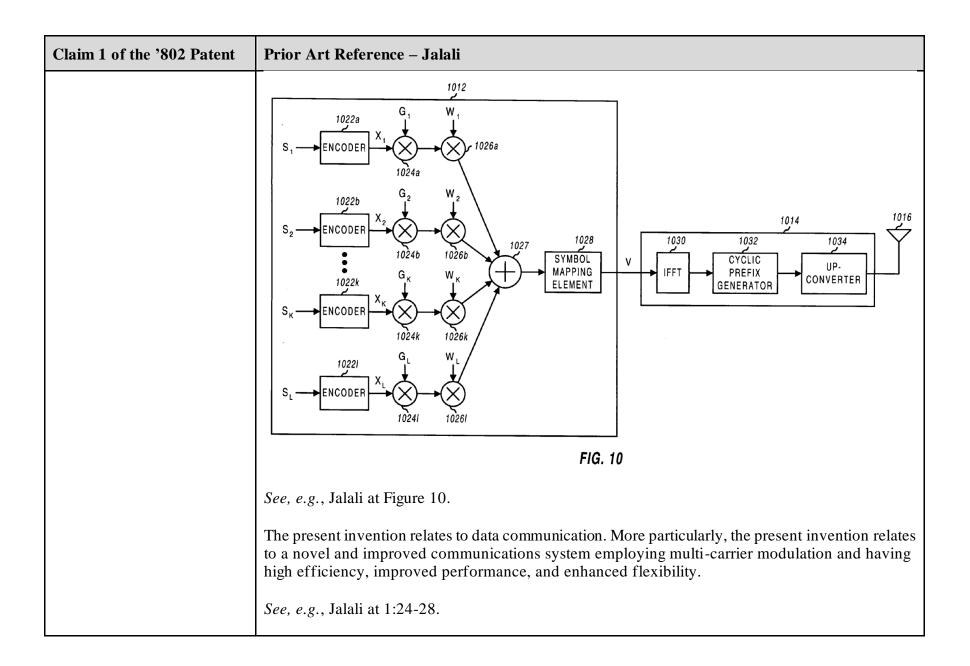
Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.3] simultaneously transmitting second information across a second frequency range using the	Jalali discloses "simultaneously transmitting second information across a second frequency range using the same wireless transmitter, the second frequency range having a second center frequency greater than the first center frequency, a second highest frequency, and a second lowest frequency." See, e.g.:
same wireless transmitter, the second frequency range having a second center frequency greater than the first center frequency, a second highest frequency, and a second lowest frequency.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ◀─
	sub-channel 1 sub-channel 2 sub-channel 3 sub-channel 4 sub-channel 5 sub-channel 6 sub-channel 7 sub-channel 10 sub-channel 10 sub-channel 11 sub-channel 12 sub-channel 13 sub-channel 14 sub-channel 15 sub-channel 15 sub-channel 16
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 ts 9
	FIG. 2
	See, e.g., Jalali at Figure 2.





Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

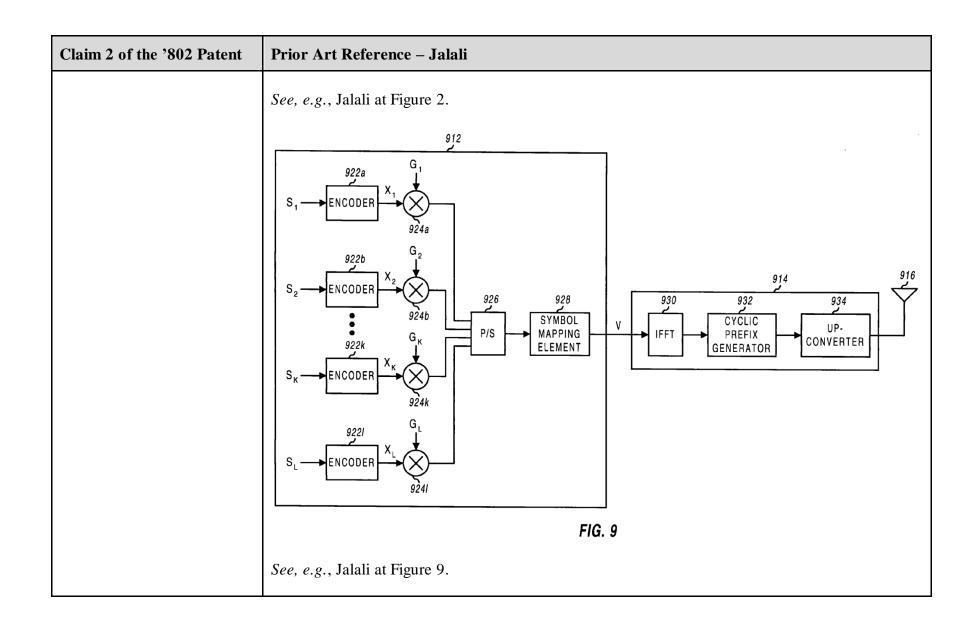
Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

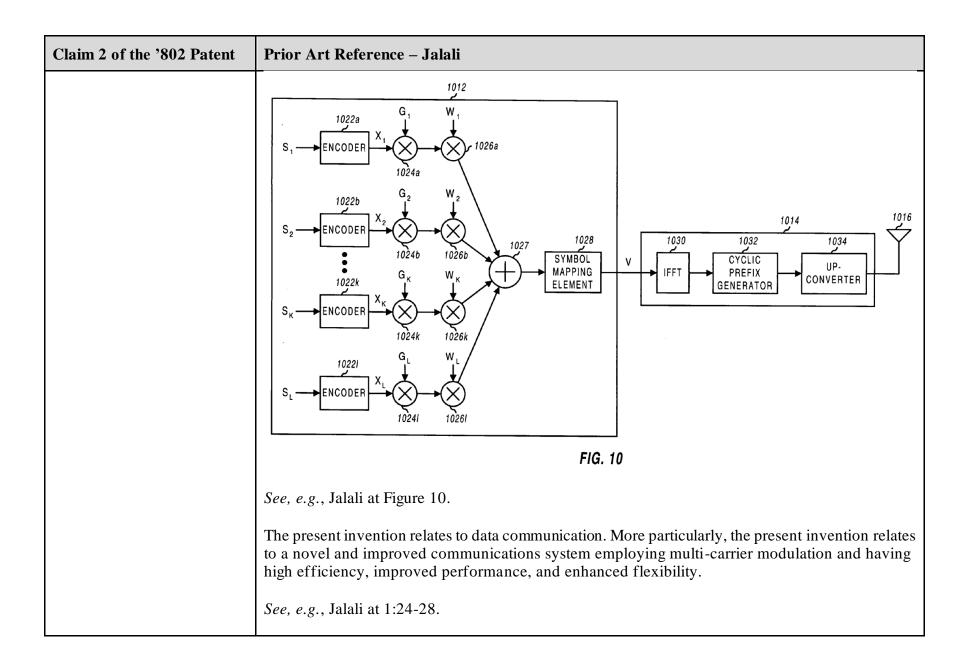
Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
[2.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[2.2] wherein frequency difference between the first center frequency and the second center frequency is	Jalali discloses "wherein frequency difference between the first center frequency and the second center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.:
greater than the sum of one- half the first frequency range	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
and one-half the second frequency range.	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	sub-channel 2  sub-channel 2  broadcast
	sub-channel 3 sub-channel 4 sub-channel 5 voice 1 voice 2 voice 3
	sub-channel 6 sub-channel 7 sub-channel 8
	sub-channel 9 sub-channel 10 sub-channel 11 data 5
	sub-channel 12 sub-channel 13 sub-channel 14
	sub-channel 15 sub-channel 16  pilot data 1 data 2 data 2 data 3 data 1 data 4 data 6  ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9





Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme c an include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

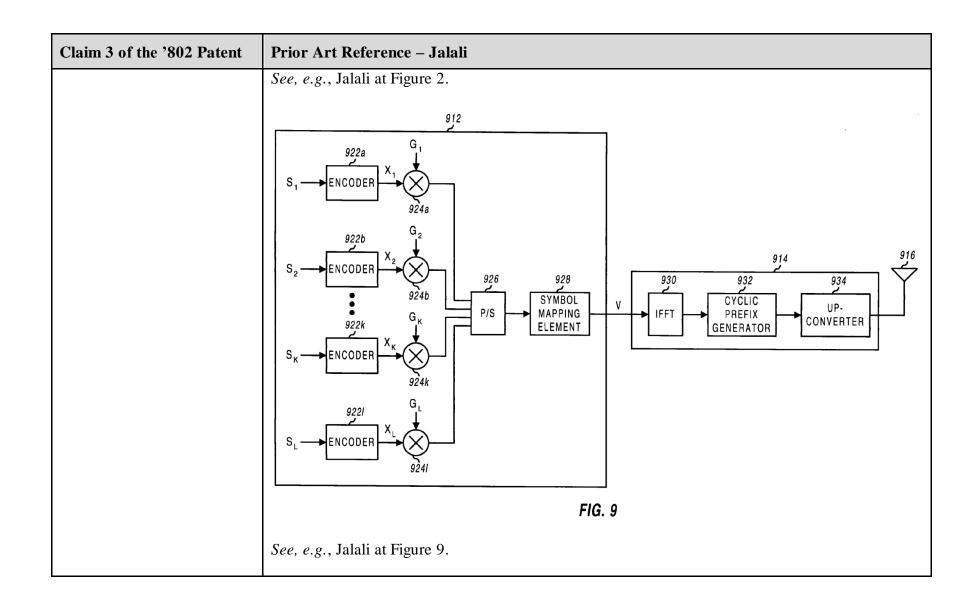
Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

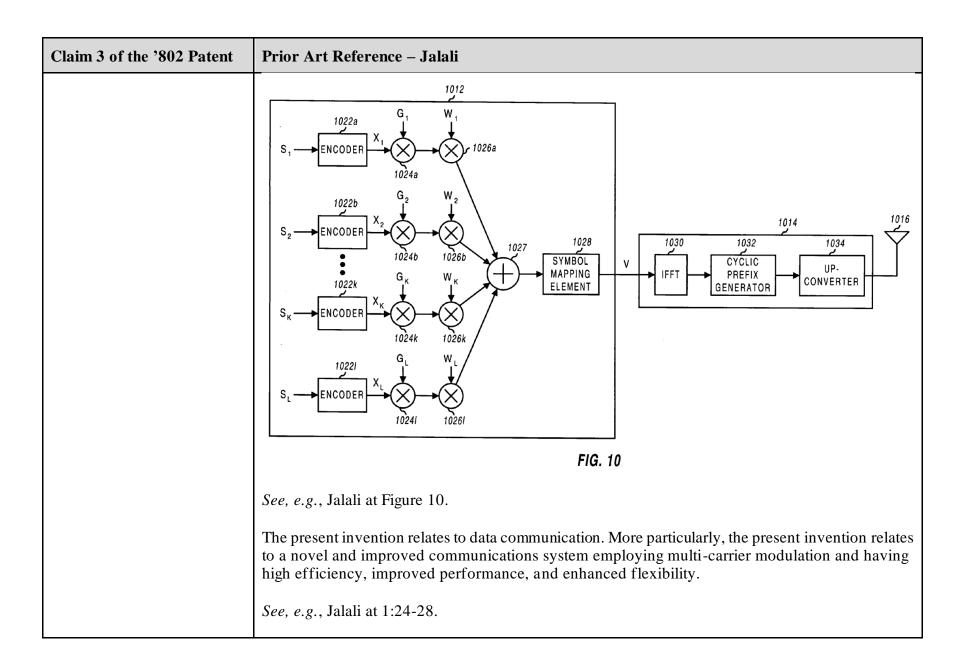
Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
[3.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[3.2] wherein the first and second information are transmitted using the same	Jalali discloses "wherein the first and second information are transmitted using the same power amplifier in said wireless transmitter." See, e.g.:
power amplifier in said wireless transmitter.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 3 of the '802 Patent	Prior Art Reference – Jalali										
	vector includ The modulate transmission. "circuits". Ea symbols, a no symbols, or s	ing a set of or modulat The data ach circuit umber of t some other cuits can b	f data values the more can be do ones from eact.	lues used odulation h coded efined to m a singlation of t	to modu symbol v data strea include a e OFDM ones. The e data (e.	late a se ectors to m is man is man numbe symbol, e circuits	t of tones provide pped to a r of tones all tones can hav	s to gener a modula a respective s from a re from one e equal si	rate an O ated sign we set of number of e or mor ize or di	of OFDM e OFDM	
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	sub-channel 3	That Trefails	voice 1 —								
	sub-channel 4	人工作	voice 2							<b>——</b>	
	sub-channel 5	2000年	///////////////////////////////////////			voice 3				<b>——</b>	
	sub-channel 6			el Tara				voice 4 -		-	
	sub-channel 7	THE TALL				I fat la			100		
	sub-channel 8	THE STATE OF		7. 5	44 1 77					1	
	sub-channel 9			1							
	sub-channel 10	25. 15. 15.				114/14					
	sub-channel 11			Mark W						data 5	
	sub-channel 12	W- YAI		ar dyna				<b>V</b> ////////////////////////////////////			
	sub-channel 13	- In									
	sub-channel 14			41.75							
	sub-channel 15	1 1 3 7 63		VAL TALLE							
	sub-channel 16	pilot 🐴	data 1	data 2	data 2	data 2	i data 3	data 1	data 4	data 6	
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9	
	FIG. 2										
	110. 2										





Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

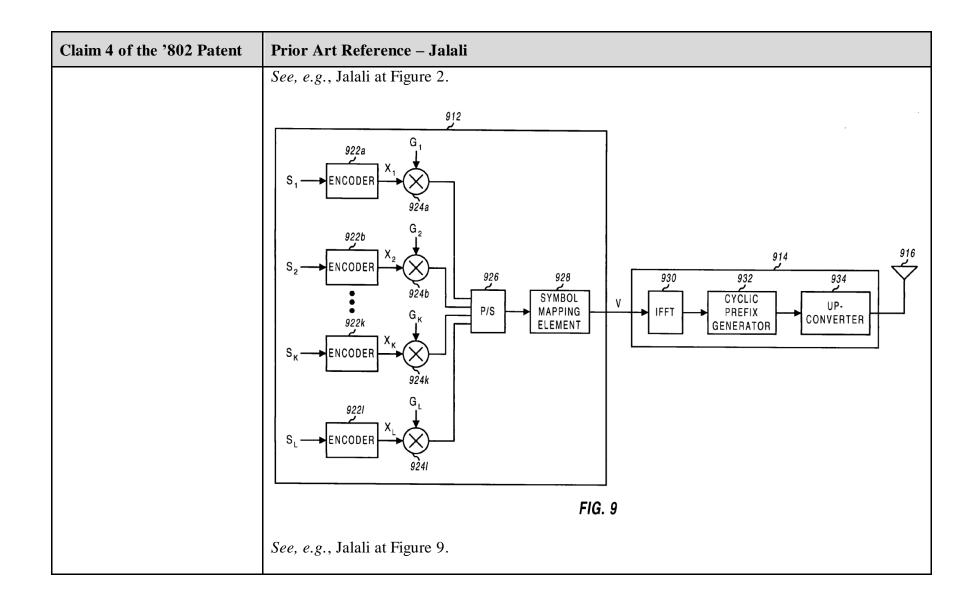
Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

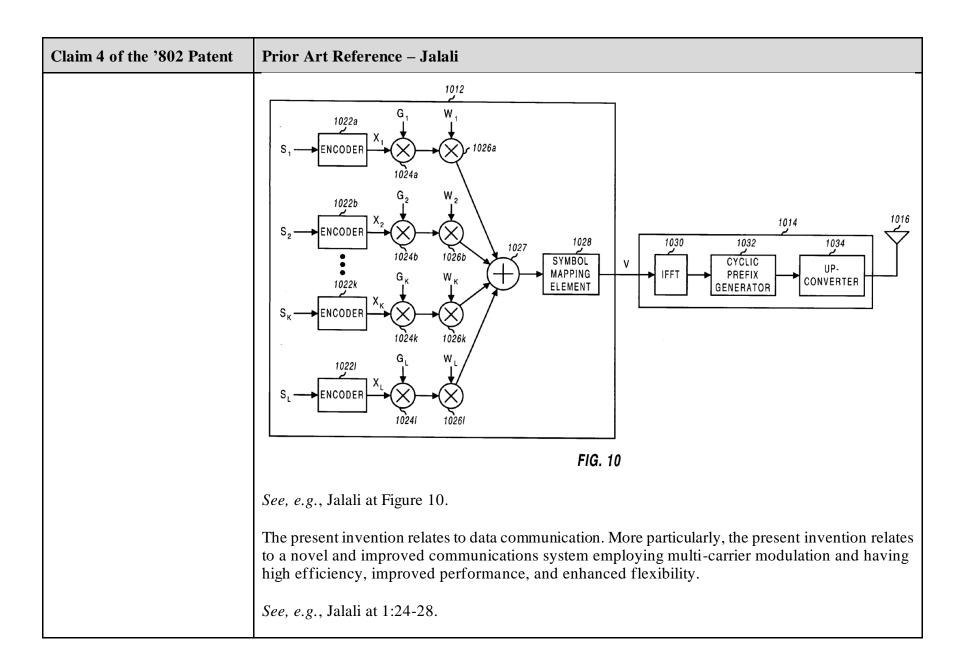
Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
[4.1] The method of claim 3	Jalali discloses all the elements of claim 3 for all the reasons provided above.
[4.2] wherein the bandwidth of said power amplifier is greater than the difference	Jalali discloses "wherein the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency." See, e.g.:
between the first lowest frequency and the second highest frequency.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 4 of the '802 Patent	Prior Art Reference – Jalali									
	vector includ The modulate transmission. "circuits". Ea symbols, a no symbols, or s	ing a set of or modulat The data ach circuit umber of t some other cuits can b	f data values the more from each can be determined to combinate used for each.	lues used odulation h coded efined to m a singlation of t	to modu symbol v data strea include a e OFDM ones. The e data (e.	late a se ectors to am is ma a numbe symbol, e circuits	t of tones provide pped to a r of tones all tones s can hav	s to gener a modula a respective s from a re from one e equal s	rate an O ated sign we set of number of e or mor ize or di	of OFDM e OFDM
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	sub-channel 3	Tag Votalis	voice 1 —							<b>——</b>
	sub-channel 4	A STATE	voice 2							
	sub-channel 5	2000年	VIIIIIIII			voice 3				<b>——</b>
	sub-channel 6			el Tales				voice 4 —		-
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	sub-channel 13	# In							i.	
	sub-channel 14			H. PA						
	sub-channel 15	i Paritali								1222 6
	sub-channel 16	pilot 🦂	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9
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					110	4. L				





Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 4 of the '802 Patent	Prior Art Reference – Jalali						
	time slots improves the likelihood of correct data reception due to, for example, impulse noise an interference.						
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.						
	See, e.g., Jalali at 8:47-9:38.						
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).						
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs						

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

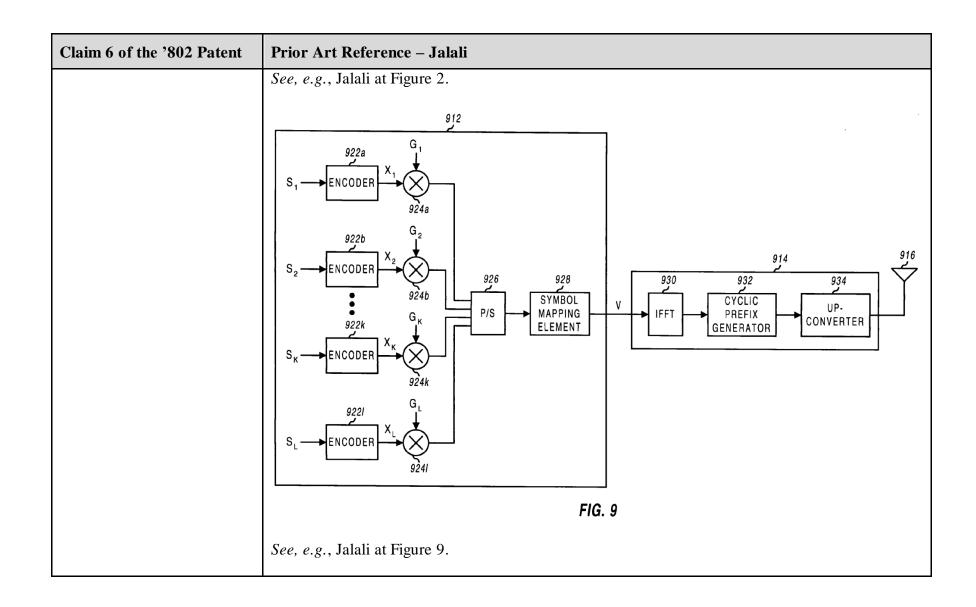
Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

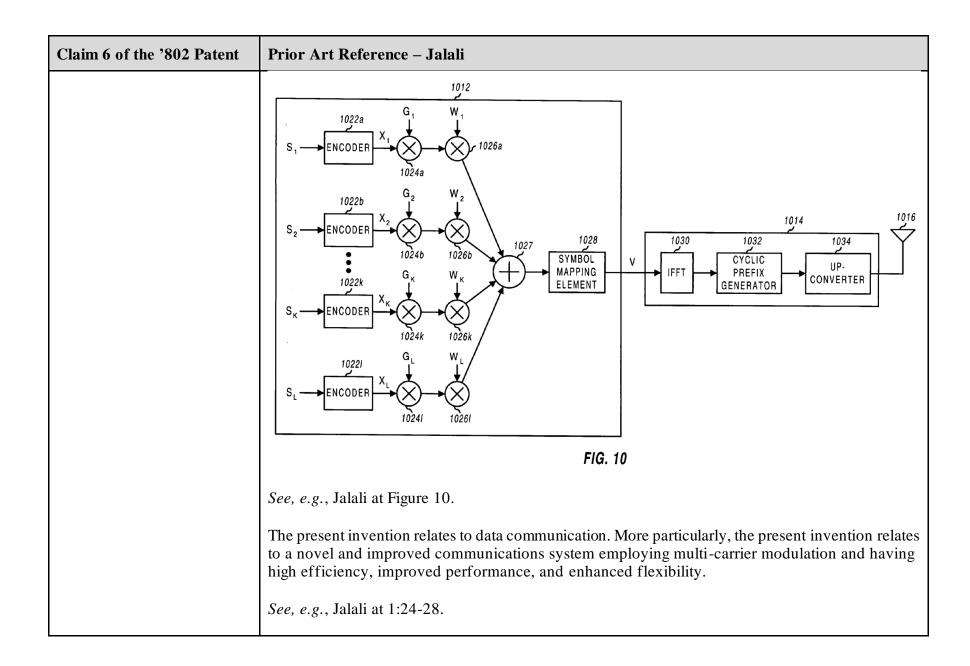
Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
[6.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[6.2] wherein the first information corresponds to a first wireless protocol and the	Jalali discloses "wherein the first information corresponds to a first wireless protocol and the second information corresponds to a second wireless protocol." See, e.g.:
second information corresponds to a second wireless protocol.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream
wheless protocol.	to generate a corresponding coded data stream. The symbol mapping element receives and maps data

e '802 Patent   Prior Art Reference – Jalali
from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
sub-channel 1 sub-channel 3 sub-channel 4 sub-channel 6 sub-channel 7 sub-channel 8 sub-channel 10 sub-channel 11 sub-channel 12 sub-channel 12 sub-channel 13 sub-channel 14 sub-channel 15 sub-channel 15 sub-channel 16 sub-channel 16 sub-channel 17 sub-channel 18 sub-channel 19 sub-channel 19 sub-channel 10 sub-channel 10 sub-channel 11 sub-channel 15 sub-channel 15 sub-channel 16 sub-channel 16 sub-channel 17 sub-channel 18 sub-channel 19 sub-channel 19 sub-channel 19 sub-channel 10 sub-channel





Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

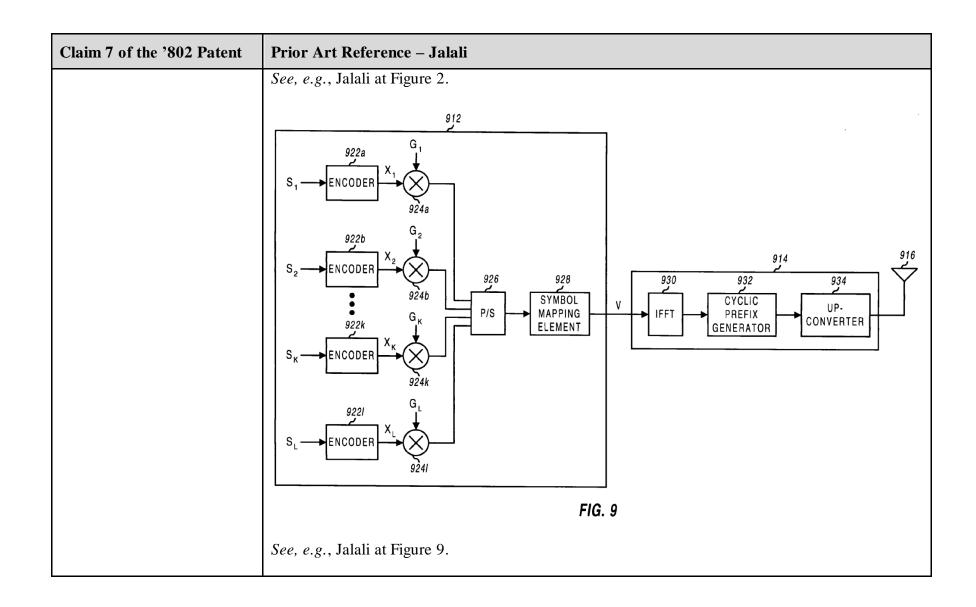
Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

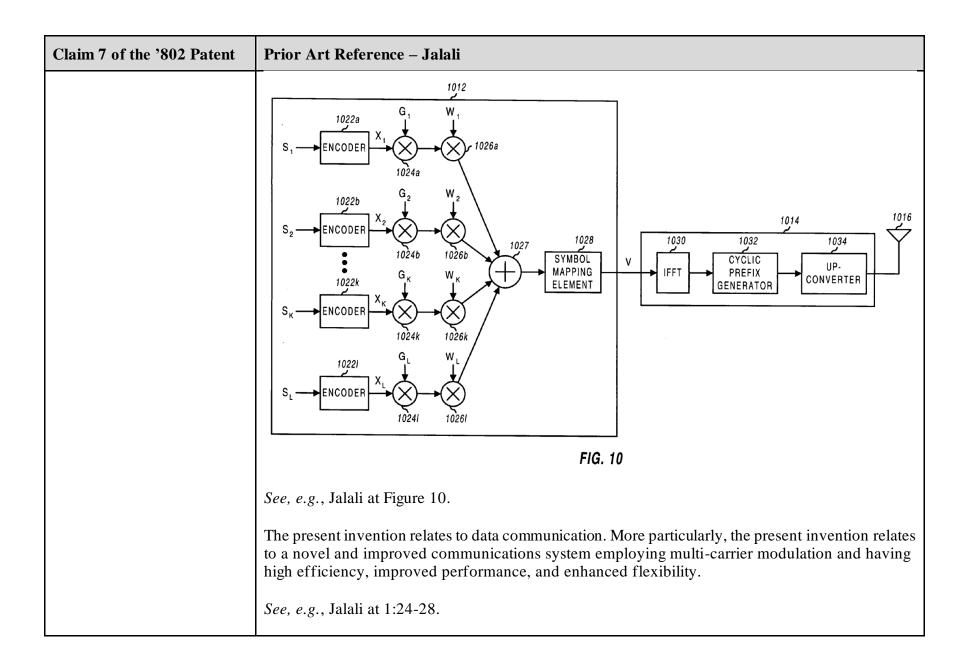
Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.  Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1-A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and
	First Supplemental Ex. A-Obviousness Chart.

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
[7.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[7.2] wherein the first information and the second information are the same data	Jalali discloses "wherein the first information and the second information are the same data transmitted across two different frequencies." See, e.g.:
transmitted across two different frequencies.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 7 of the '802 Patent	Prior Art Re	eference –	Jalali								
	from the code vector including The modulator transmission. "circuits". Easymbols, a nusymbols, or subject transmission. See, e.g., Jala	ing a set of or modulate. The data the ach circuit cumber of to some other cuits can be	data values the mo from each can be do ones from combinate used for	ues used dulations he coded defined to a single ation of to	to modu ymbol v lata strea include a OFDM ones. The	late a set ectors to m is map a number symbol, a e circuits	of tones provide a oped to a of tones all tones can have	to general modula respective from a refrom one equal si	ate an OI ated signate we set of number of e or more ze or dif	FDM symbal suitable one or moon of OFDM e OFDM ferent size	for ore
	sub-channel 1 sub-channel 2 sub-channel 3 sub-channel 4		control — broadcast — voice 1 — voice 2 —	OFDM symbol ◀						<b>*</b>	
	sub-channel 5 sub-channel 7 sub-channel 8 sub-channel 9 sub-channel 10 sub-channel 11				THE THE PARTY NAMED IN COLUMN TWO IN COLUMN	voice 3		voice 4 —		data 5	
	sub-channel 12 sub-channel 13 sub-channel 14 sub-channel 15 sub-channel 16	pilot 4	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6	Time
		īs i	15 2	15 3	FIG						





Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

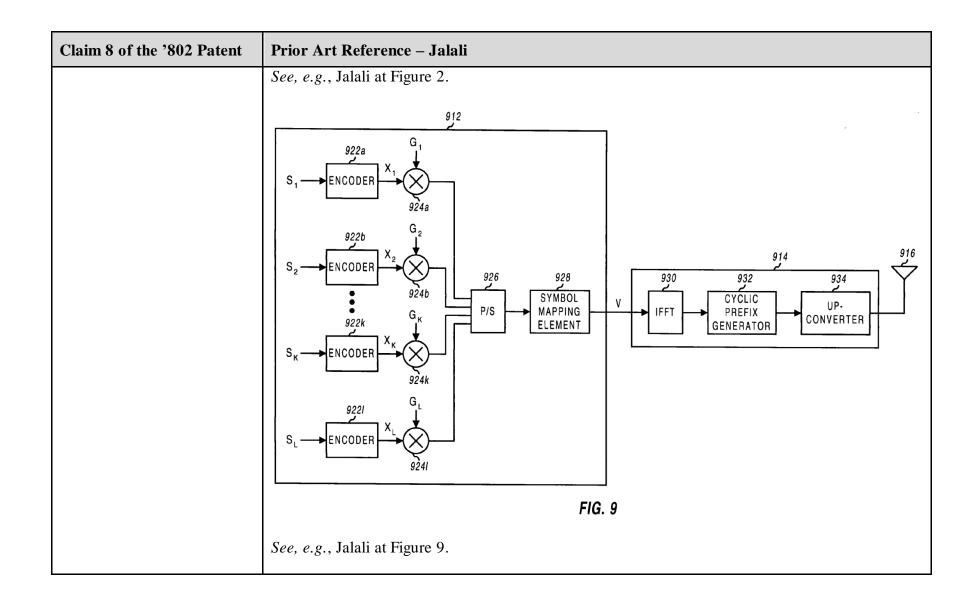
Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

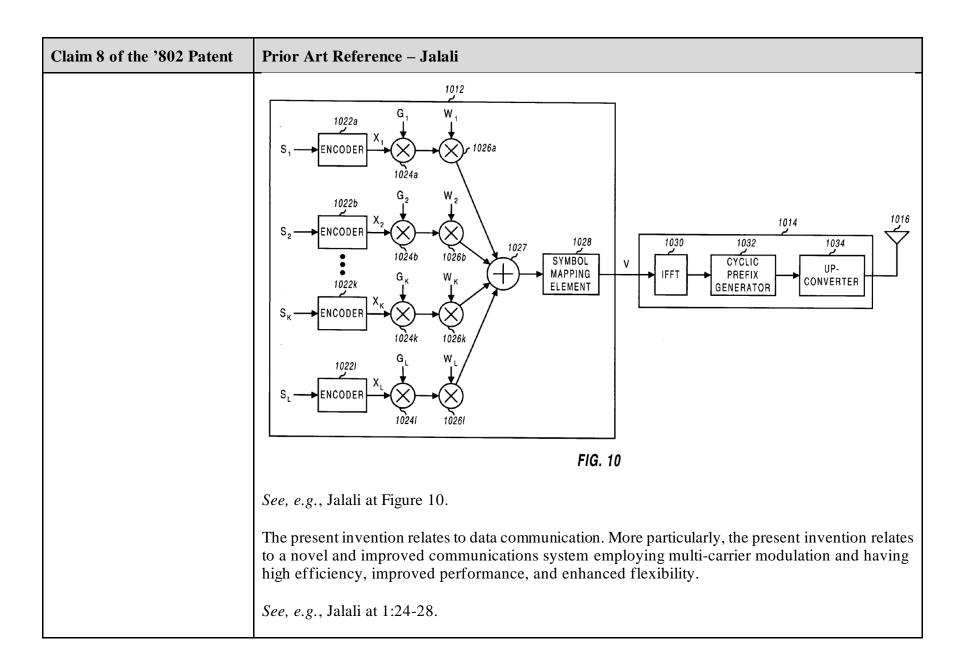
Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.  Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1—A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
[8.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[8.2] wherein the first information and the second information are from the same	Jalali discloses "wherein the first information and the second information are from the same data stream." See, e.g.:
data stream.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 8 of the '802 Patent	Prior Art Re	ference –	Jalali								
	from the code vector included The modulated transmission. "circuits". Easymbols, a number symbols, or subject to periods).  See, e.g., Jala	ing a set of or modulat The data ch circuit amber of t ome other cuits can b	f data values the more can be do ones from each combinate used for eact.	lues used odulations the coded of the coded	to moduly moduly with a stream of the control of th	late a set vectors to am is map a number symbol, e circuits	of tones provide pped to a of tones all tones can have	s to general a modula respective from a refrom one equal si	ate an O ated sign we set of number of e or mor ze or dif	FDM symbolal suitable for one or more of OFDM e OFDM ferent sizes	ol. or e
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	sub-channel 2 sub-channel 3	THE TOURS	voice 1 —								
	sub-channel 4		voice 2 —							-	
	sub-channel 5			16.6		voice 3				<b>—</b>	
	sub-channel 6							voice 4 —		-	
	sub-channel 7	A PASS			J. Sa. H				1. 1. 2		
	sub-channel 8	A FEB A			AN LETT						
	sub-channel 9	F		1 4 41	11491					6	
	sub-channel 10									data 5	
	sub-channel 11 sub-channel 12			74 14 T							
	sub-channel 13	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1									
	sub-channel 14										
	sub-channel 15			WAY YELL A					$(e^{-1})$		
	sub-channel 16	pilot	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6	
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Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

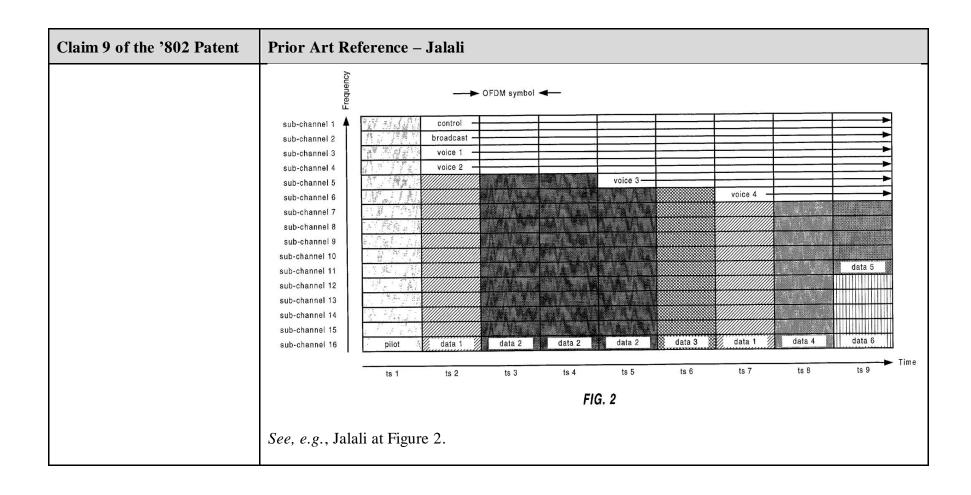
Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

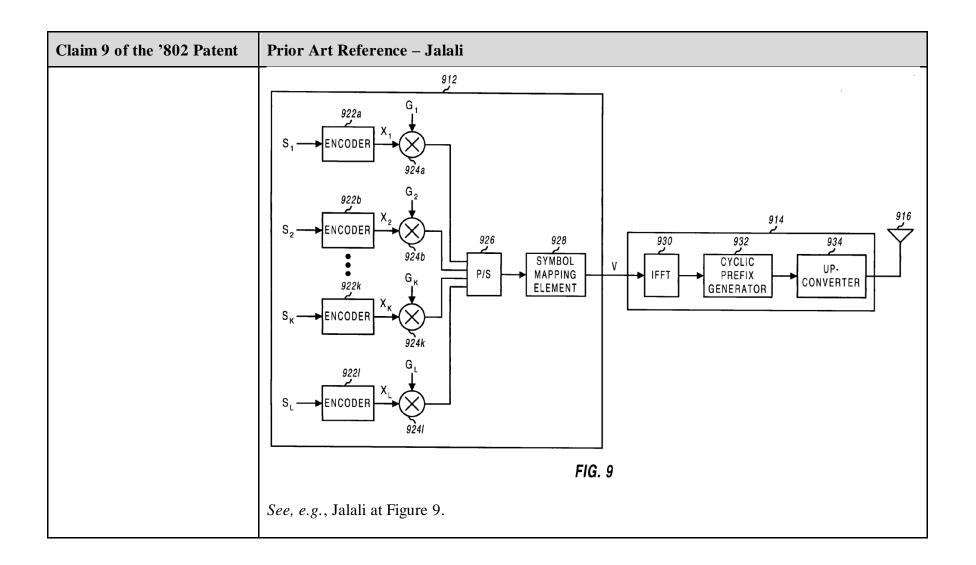
Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

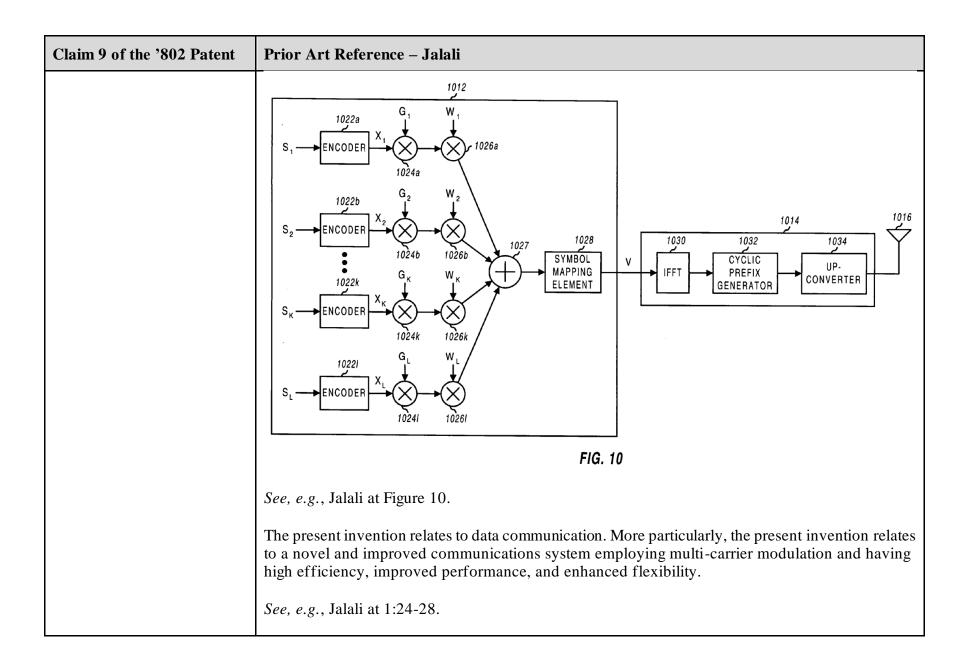
Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
[9.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[9.2] wherein first information and second information comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a	Jalali discloses "wherein first information and second information comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first frequency range and a second symbol is transmitted during the first time slot across the second frequency range, and wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range." See, e.g.:
first time slot across the first frequency range and a second	Tourm symbol is transmitted during the second time slot across a second frequency range. See, e.g.:

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
symbol is transmitted during the first time slot across the second frequency range, and wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.







Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

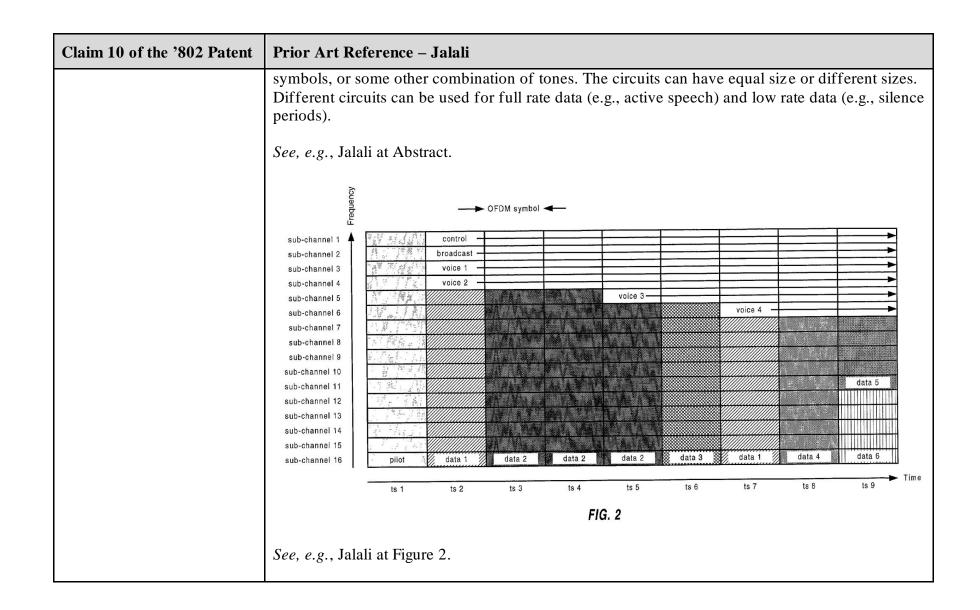
Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

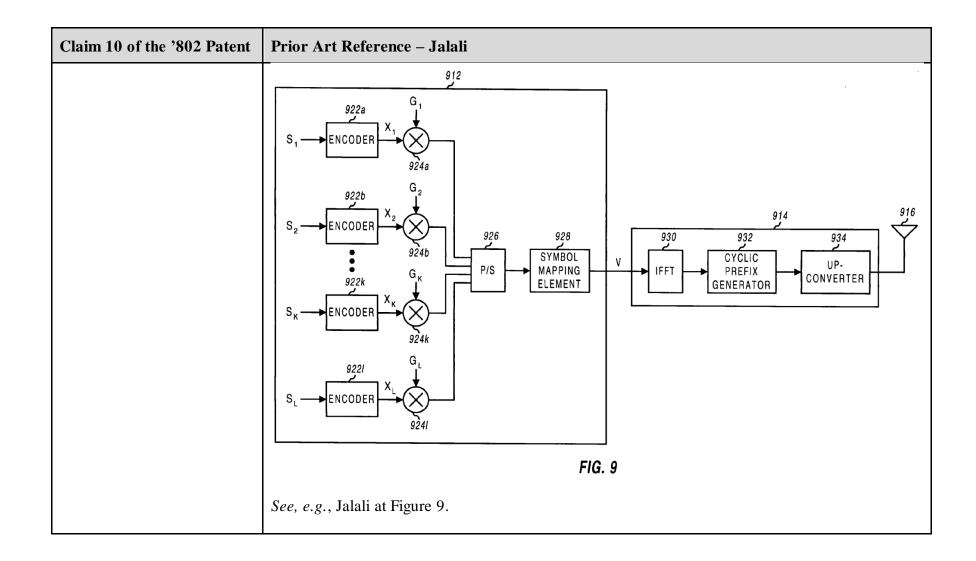
Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

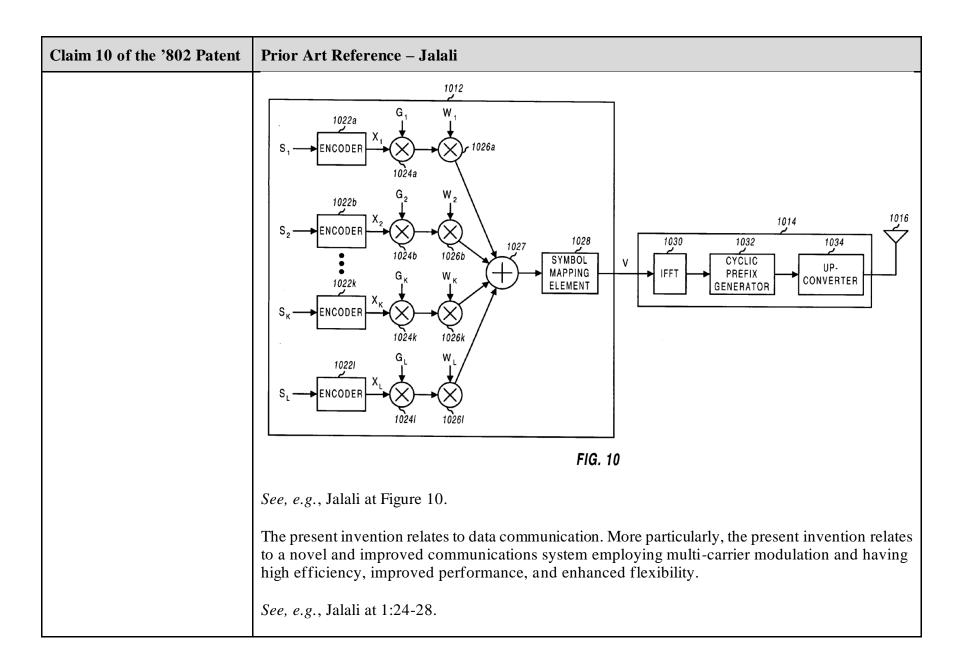
Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
[10.1] A method of transmitting information in a wireless communication	To the extent the preamble is limiting, Jalali discloses "A method of transmitting information in a wireless communication channel comprising." See, e.g.:
channel comprising:	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.2] receiving a first digital signal comprising first data to	Jalali discloses "receiving a first digital signal comprising first data to be transmitted." See, e.g.:
be transmitted;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM







Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

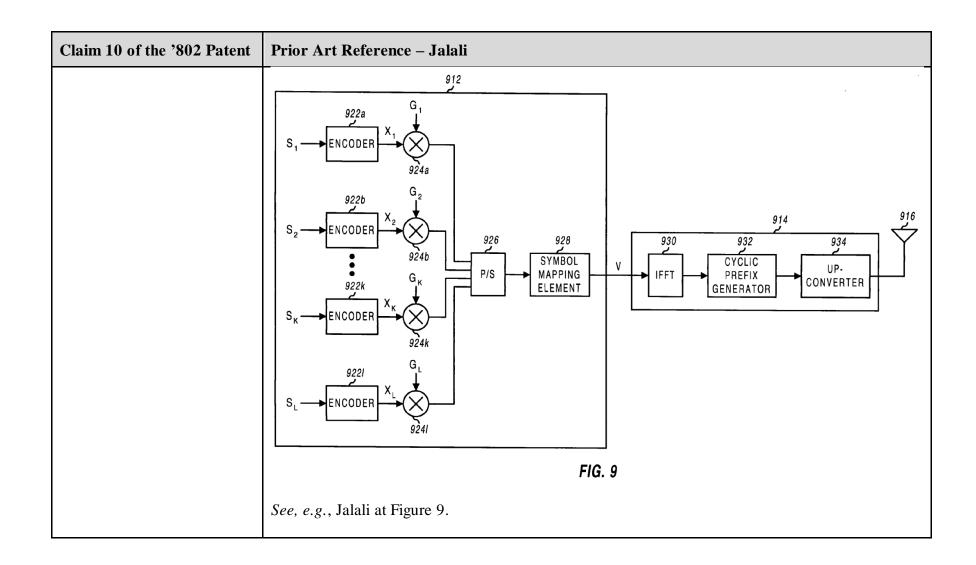
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

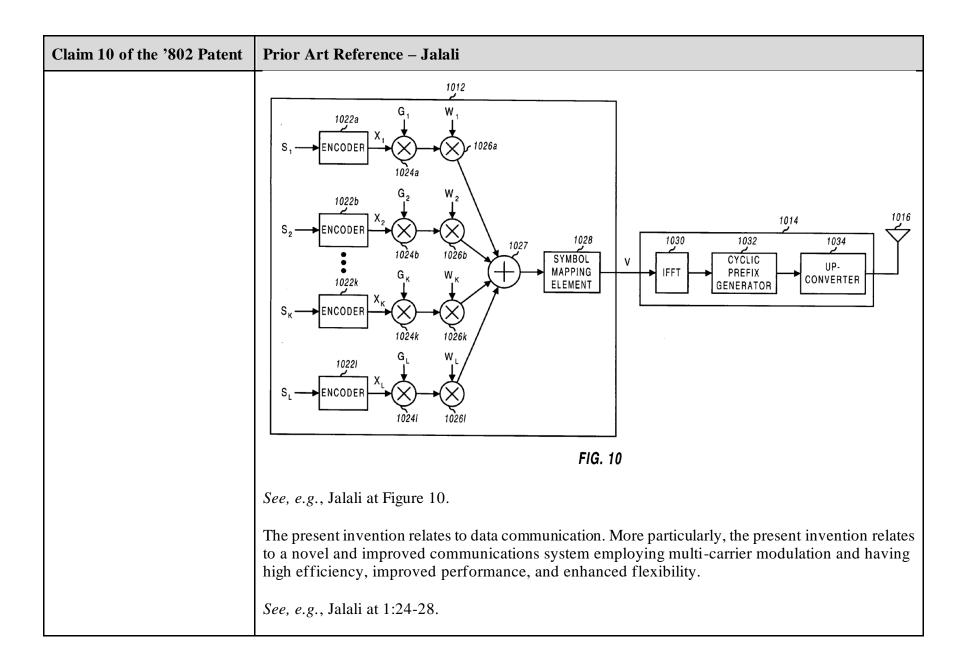
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.3] receiving a second digital signal comprising second data to be transmitted;	Jalali discloses "receiving a second digital signal comprising second data to be transmitted." See, e.g.:
	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ←
	sub-channel 1 A Park * 1.4 (1)   control
	sub-channel 2 broadcast
	sub-channel 3
	sub-channel 4 voice 2
	sub-channel 5 voice 3
	sub-channel 6 voice 4 voice 4
	sub-channel 7
	sub-channel 8
	sub-channel 9 sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

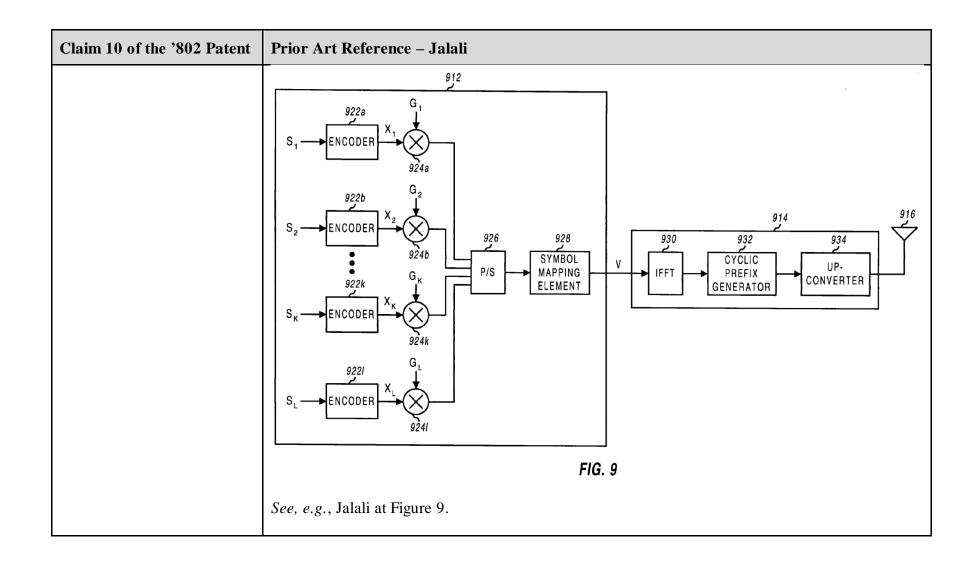
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

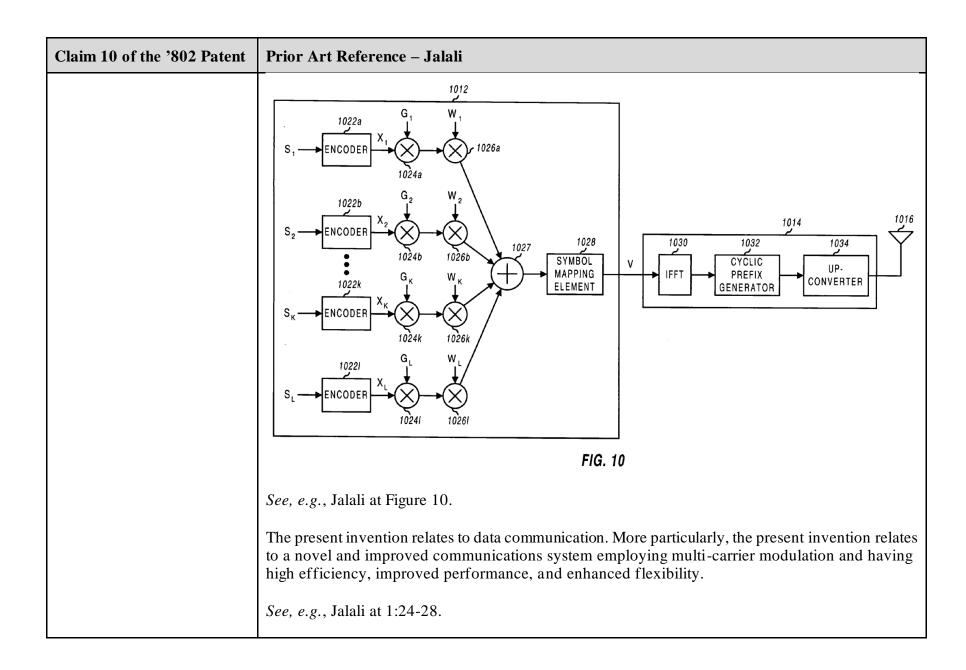
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.4] converting the first digital signal into a first analog signal using a first digital-to-analog converter,	Jalali discloses "converting the first digital signal into a first analog signal using a first digital-to-analog converter, the first analog signal carrying the first data across a first frequency range." See, e.g.:
the first analog signal carrying the first data across a first frequency range;.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.
	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silenc periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀──
	sub-channel 1 A Control
	sub-channel 2 broadcast
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5 voice 3 voice 4
	Sub-chainlet 0
	sub-channel 7 sub-channel 8
	sub-channel 9
	sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot 4 data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Tim
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

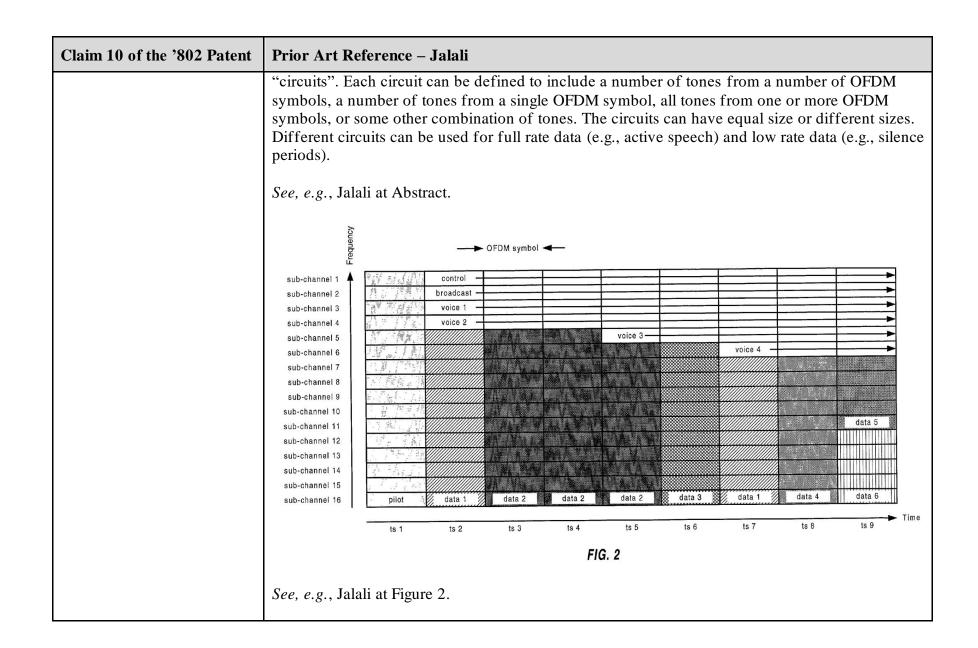
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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

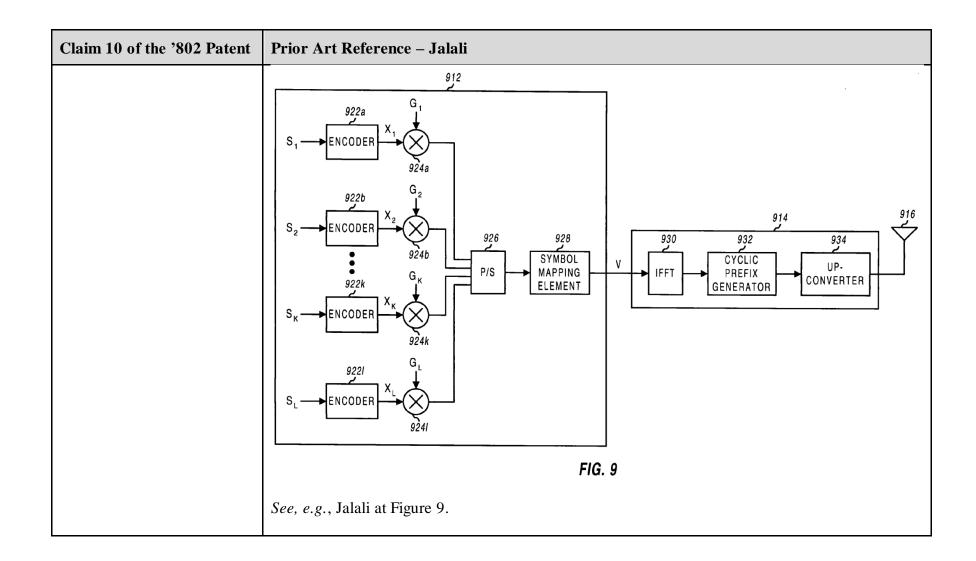
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

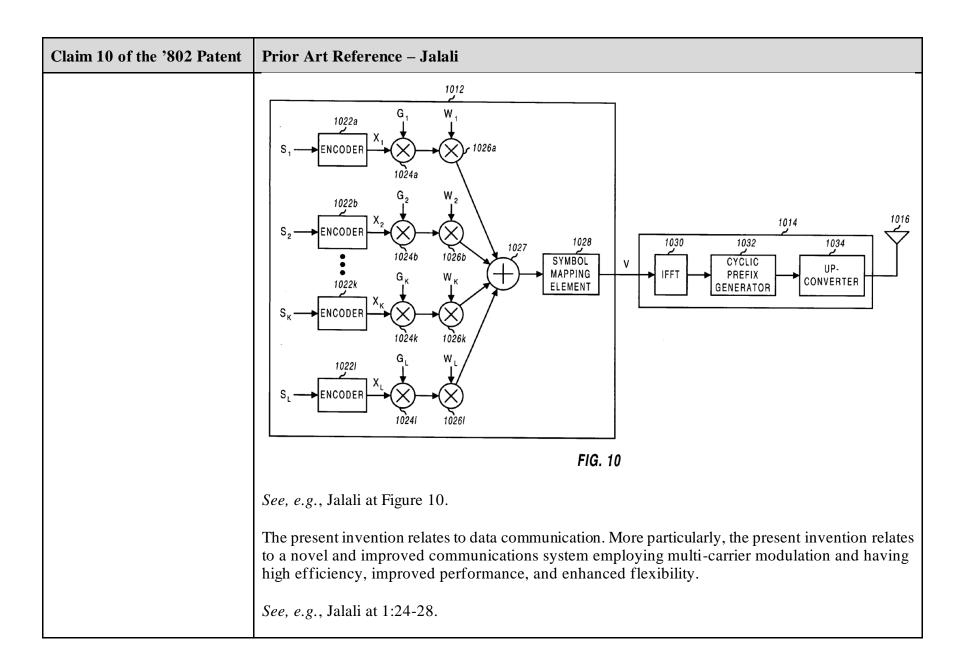
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.5] converting the second digital signal into a second analog signal using a second digital-to-analog converter,	Jalali discloses "converting the second digital signal into a second analog signal using a second digital-to-analog converter, the second analog signal carrying the second data across a second frequency range." See, e.g.:
the second analog signal carrying the second data across a second frequency	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream
range;	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more







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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

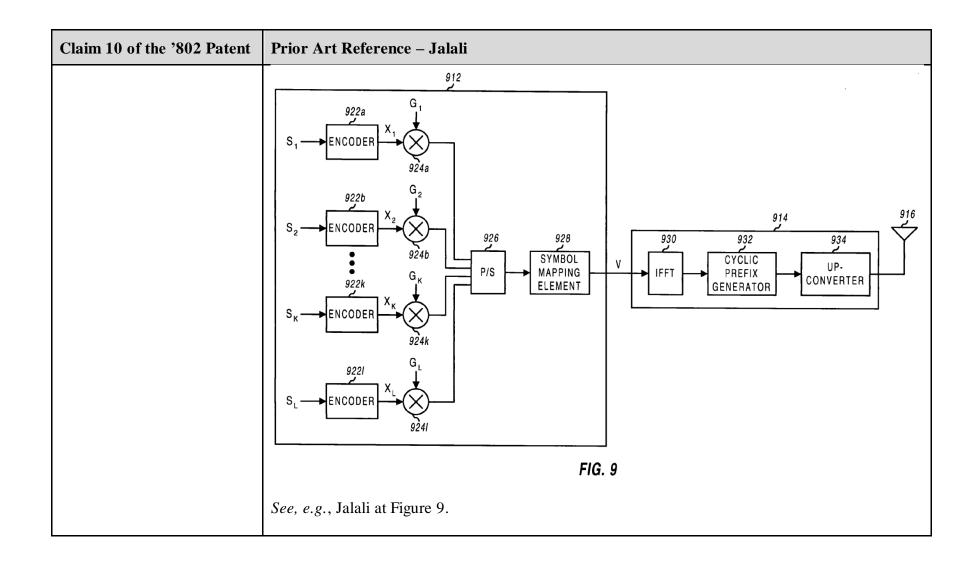
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

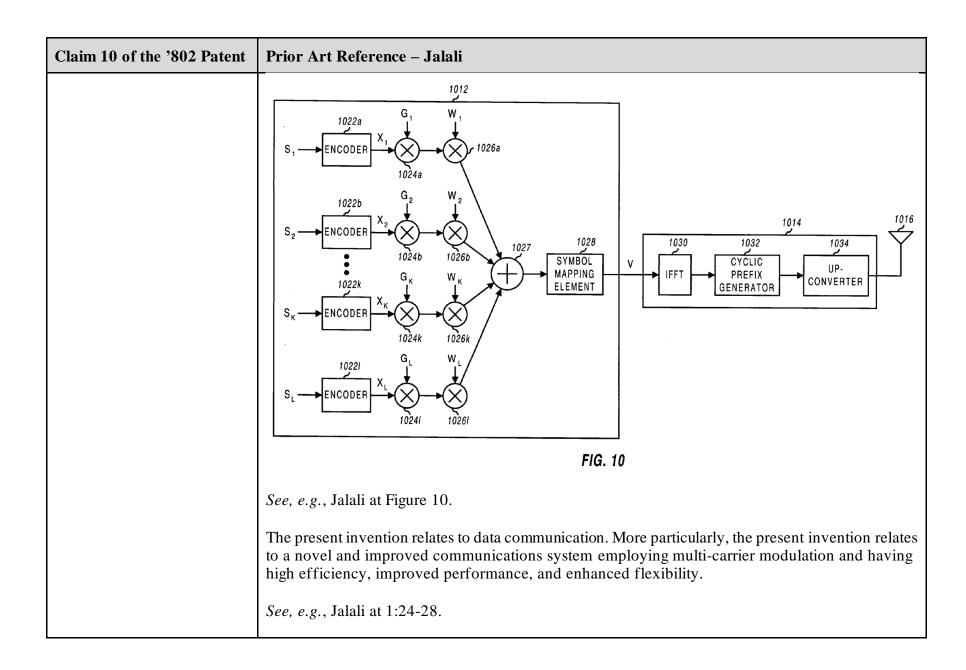
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.6] up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-	Jalali discloses "up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-converted analog signal comprises a first up-converted frequency range from the first RF center frequency minus one-half the first frequency range to the first RF center frequency plus one-half the first frequency range." See, e.g.:
converted analog signal comprises a first up-converted frequency range from the first	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream
RF center frequency minus one-half the first frequency range to the first RF center	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

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frequency plus one-half the first frequency range;	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ◀—
	sub-channel 1 control sub-channel 2 broadcast broadcast
	sub-channel 3 sub-channel 4 sub-channel 5  voice 1  voice 2  voice 3
	sub-channel 6 sub-channel 7 sub-channel 8
	sub-channel 9 sub-channel 10  sub-channel 10  data 5
	sub-channel 11 sub-channel 12 sub-channel 13
	sub-channel 14       sub-channel 15       sub-channel 16       pilot       data 1       data 2       data 3       data 1       data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Time
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.7] up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal	Jalali discloses "up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal comprises a second up-converted frequency range from the second RF center frequency minus one-half the second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.:
comprises a second up- converted frequency range from the second RF center frequency minus one-half the	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

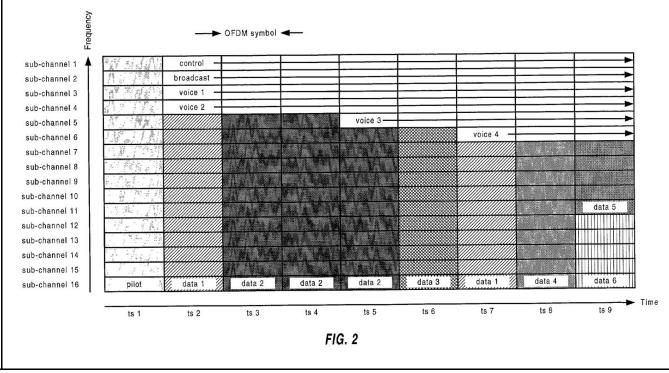
## Claim 10 of the '802 Patent

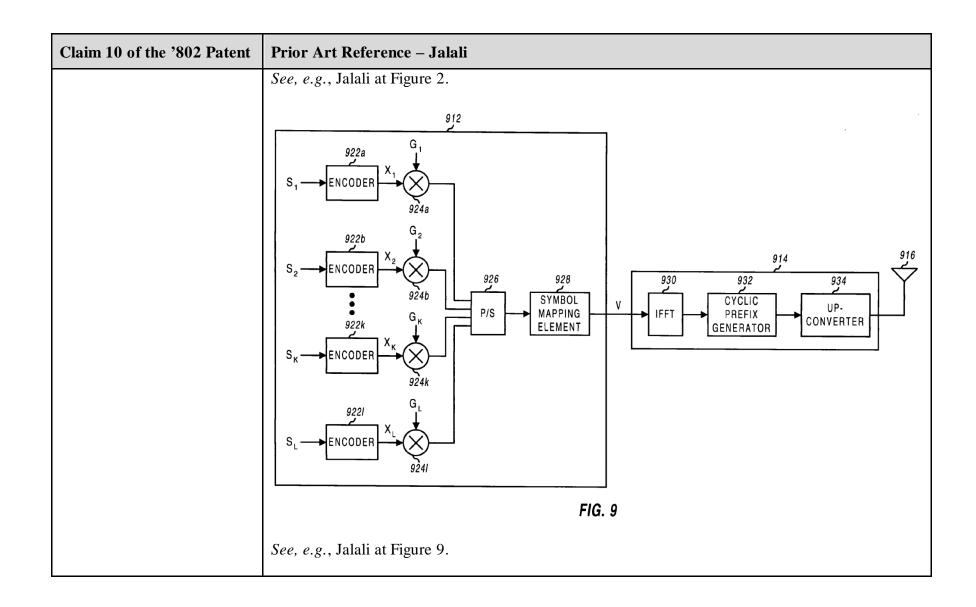
second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range;

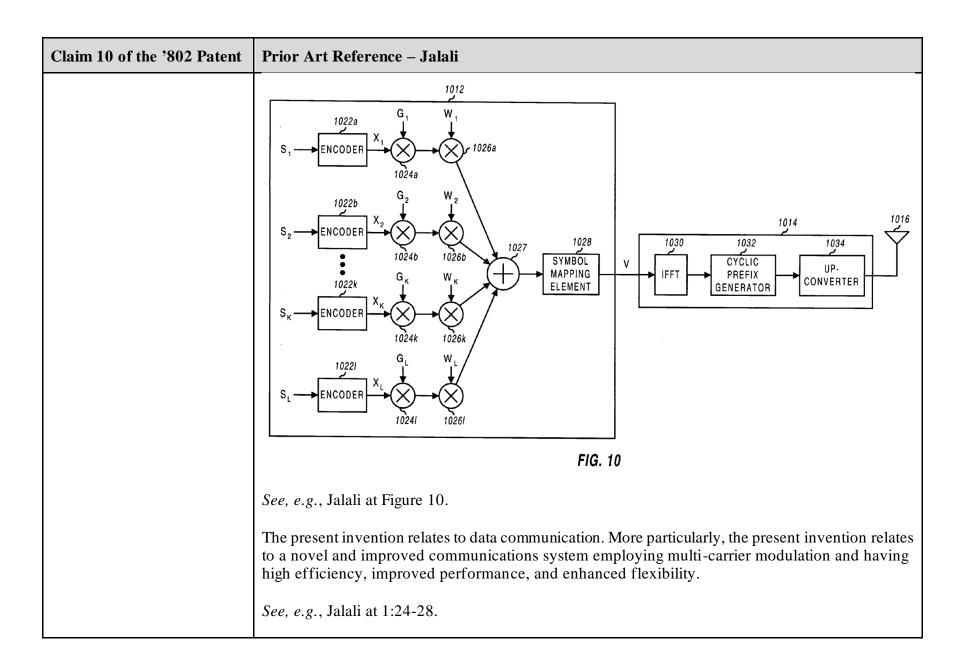
## **Prior Art Reference – Jalali**

from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).

See, e.g., Jalali at Abstract.







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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

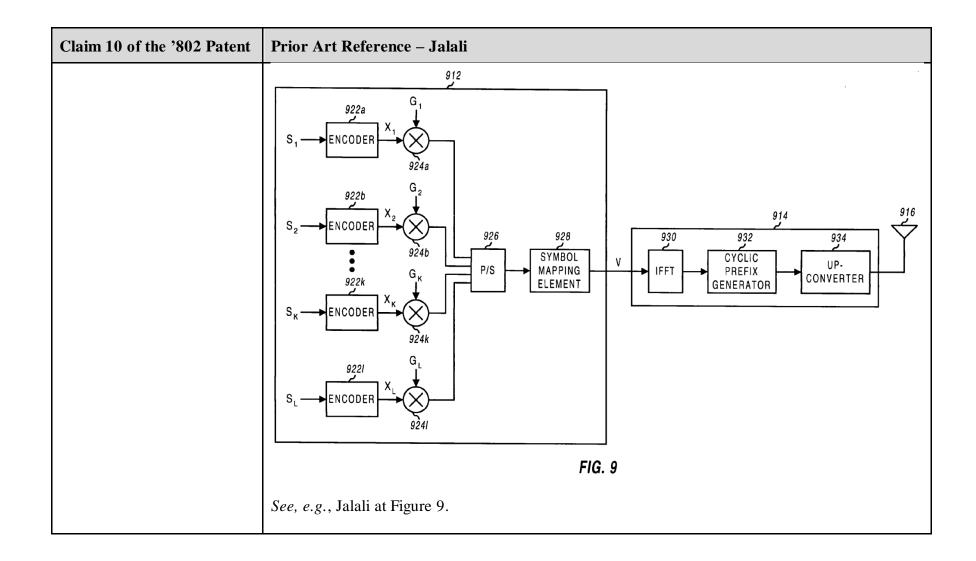
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

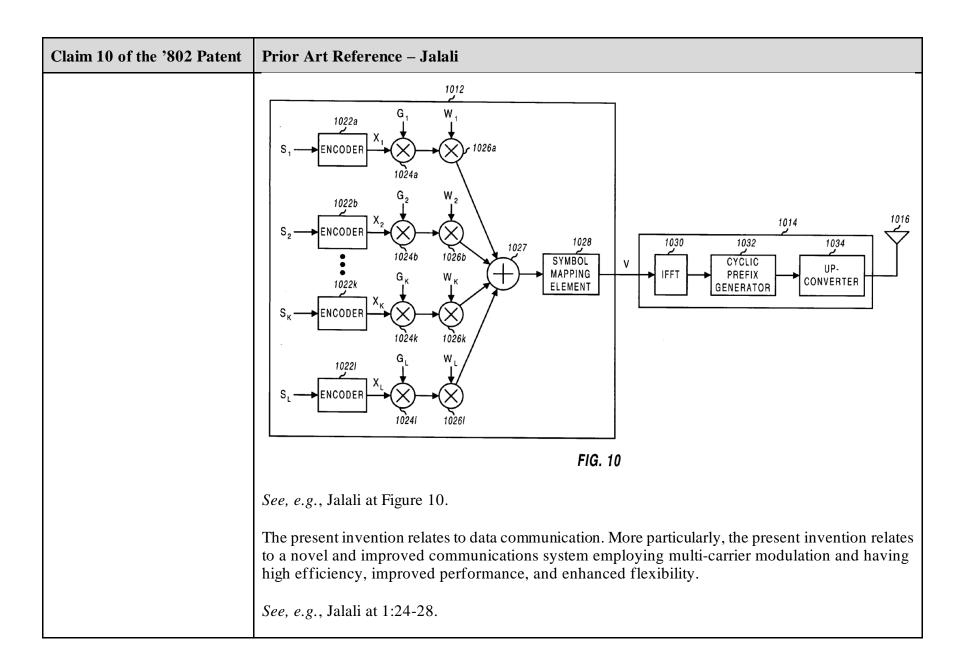
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.8] combining the first up- converted analog signal and the second up-converted	Jalali discloses "combining the first up-converted analog signal and the second up-converted analog signal to produce a combined up-converted signal." See, e.g.:
analog signal to produce a combined up-converted signal;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ◀──
	sub-channel 1 ♠ Fig * * (f)   control →
	sub-channel 2 broadcast
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5 voice 3
	sub-channel 6 voice 4
	sub-channel 7
	sub-channel 8
	sub-channel 10
	sub-channel 10 sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

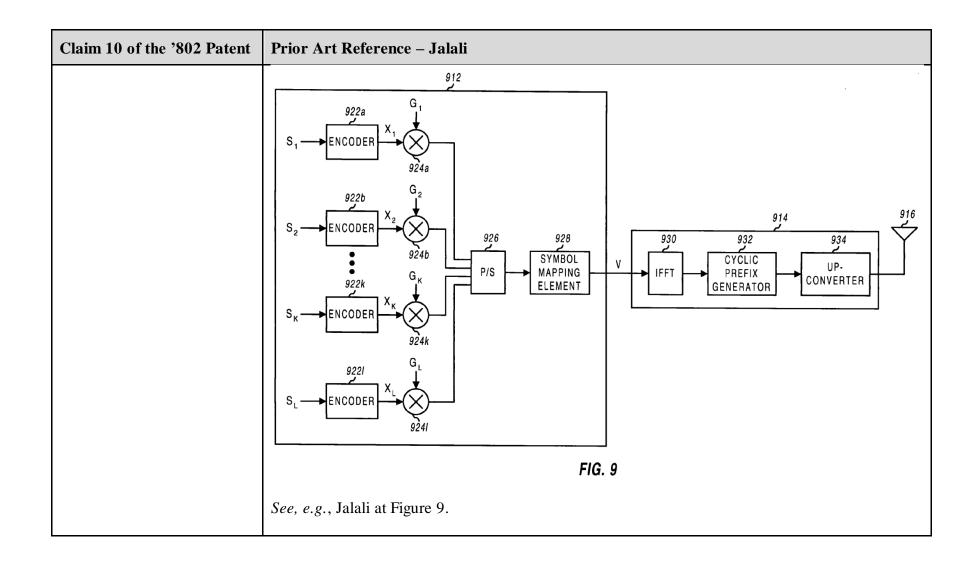
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

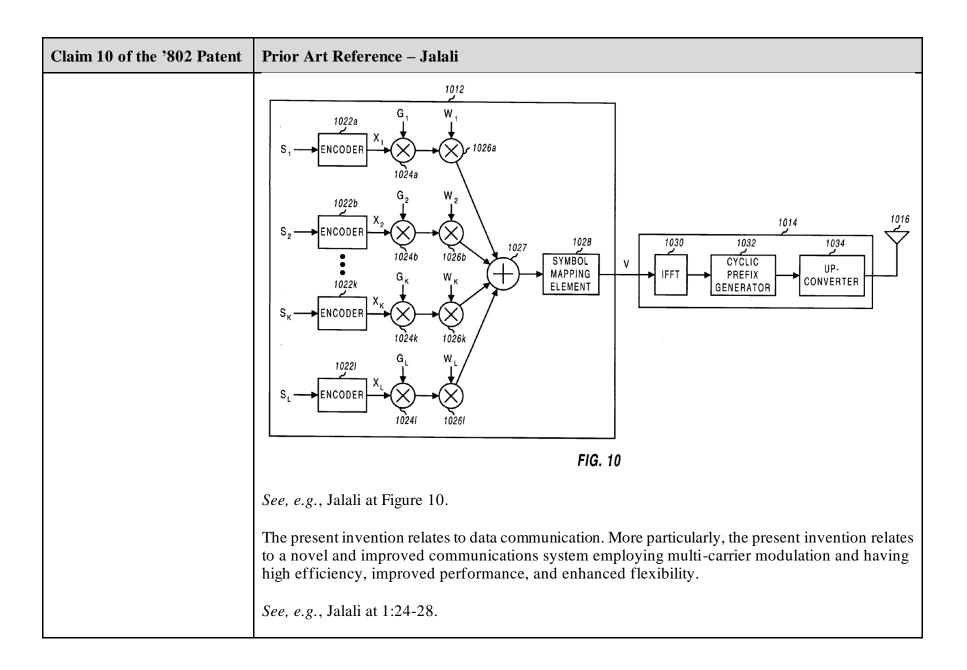
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.9] amplifying the combined up-converted signal in a power amplifier resulting	Jalali discloses "amplifying the combined up-converted signal in a power amplifier resulting in an amplified combined up-converted signal." See, e.g.:
in an amplified combined up- converted signal; and	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀──
	sub-channel 1 sub-channel 2 sub-channel 3 sub-channel 4 voice 1 voice 2
	sub-channel 5 sub-channel 6 sub-channel 7 sub-channel 8 sub-channel 9
	sub-channel 10 sub-channel 11 sub-channel 12 sub-channel 13
	sub-channel 14 sub-channel 15 sub-channel 16  pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6  ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

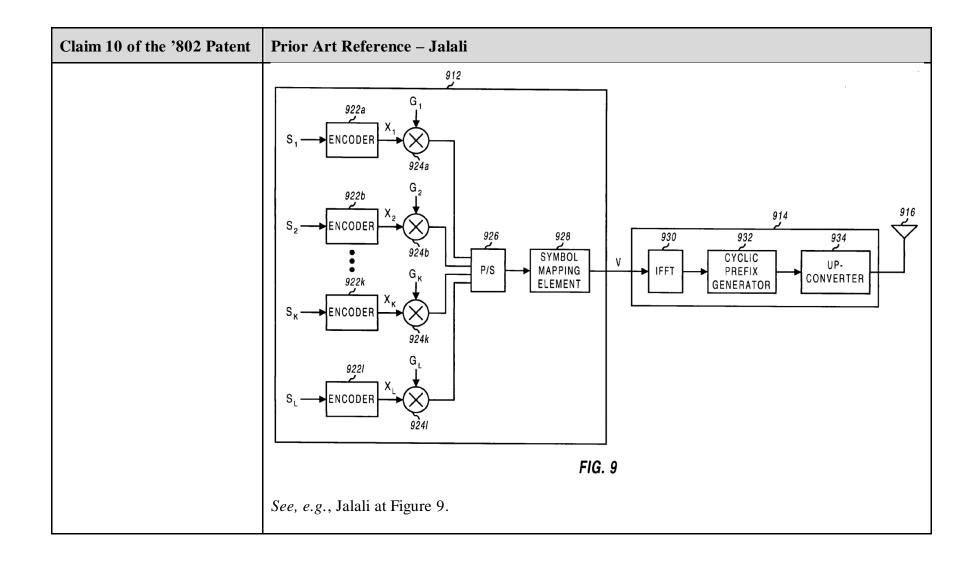
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

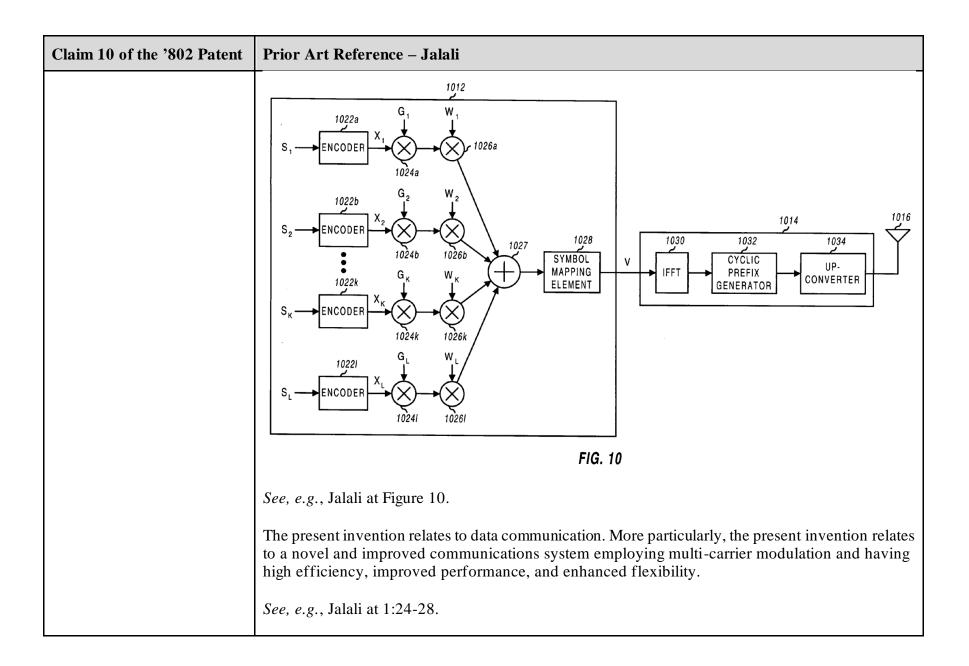
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.10] transmitting the amplified combined upconverted signal on a first antenna,	Jalali discloses "transmitting the amplified combined up-converted signal on a first antenna." See, e.g.:
	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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	symbols, a number of tones from a single OFDM symbol, all tones from one or mosymbols, or some other combination of tones. The circuits can have equal size or oblifferent circuits can be used for full rate data (e.g., active speech) and low rate data periods).	different sizes.
	See, e.g., Jalali at Abstract.	
	OFDM symbol ◀	
	sub-channel 1 A September 2 Control	<b>—</b>
	sub-channel 2	<b>—</b>
	sub-channel 3 voice 1	<b>—</b>
	sub-channel 4 voice 2	
	sub-channel 5 voice 3	
	sub-channel 6 voice 4 voice 4	
	sub-channel 7	
	sub-channel 8	(1900) (1900)
	sub-channel 9 sub-channel 10	
	sub-channel 11	data 5
	sub-channel 12	
	sub-channel 13	
	sub-channel 14	
	sub-channel 15	
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4	data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8	ts 9
	FIG. 2	
	See, e.g., Jalali at Figure 2.	





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

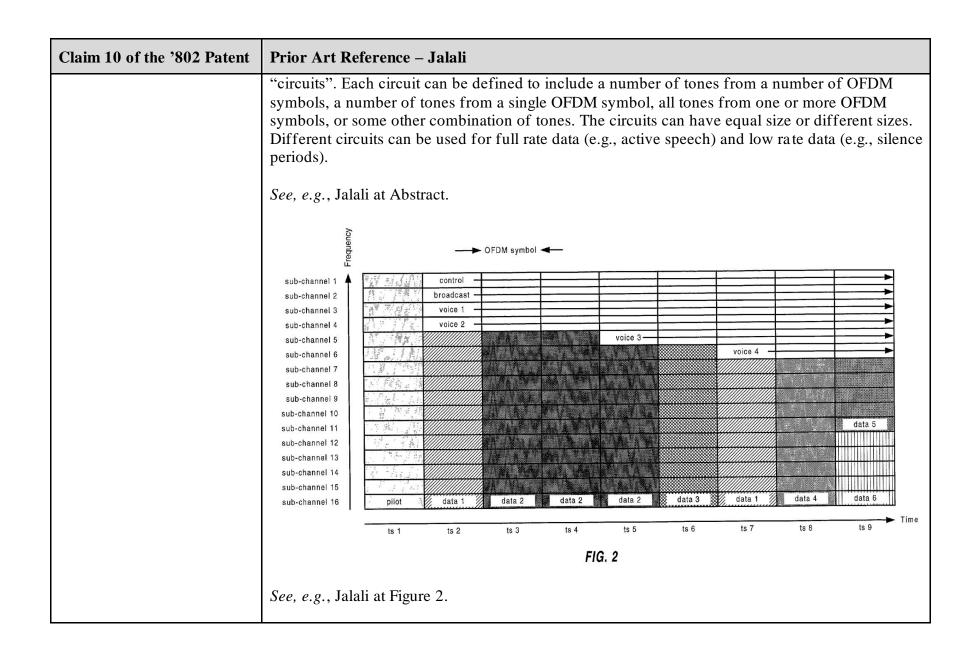
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

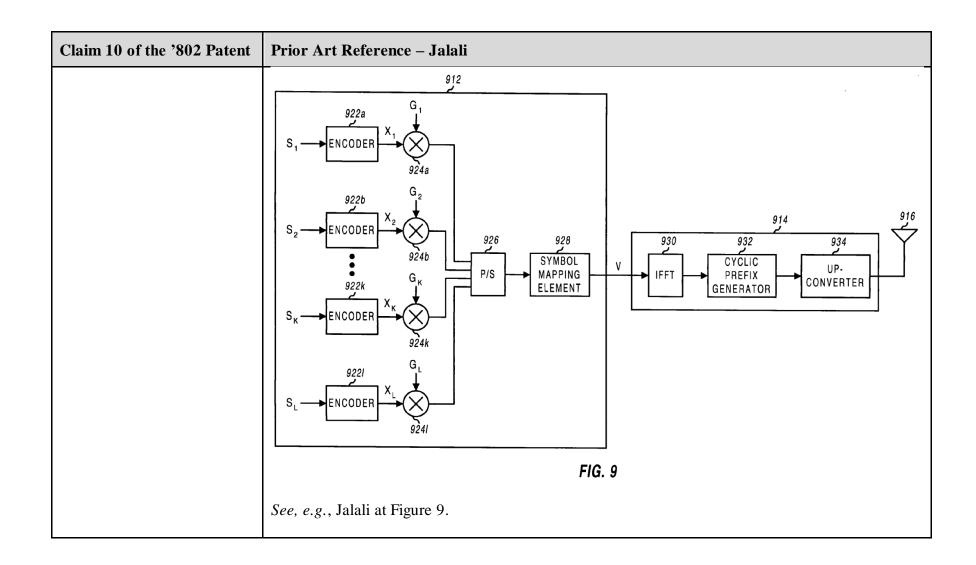
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

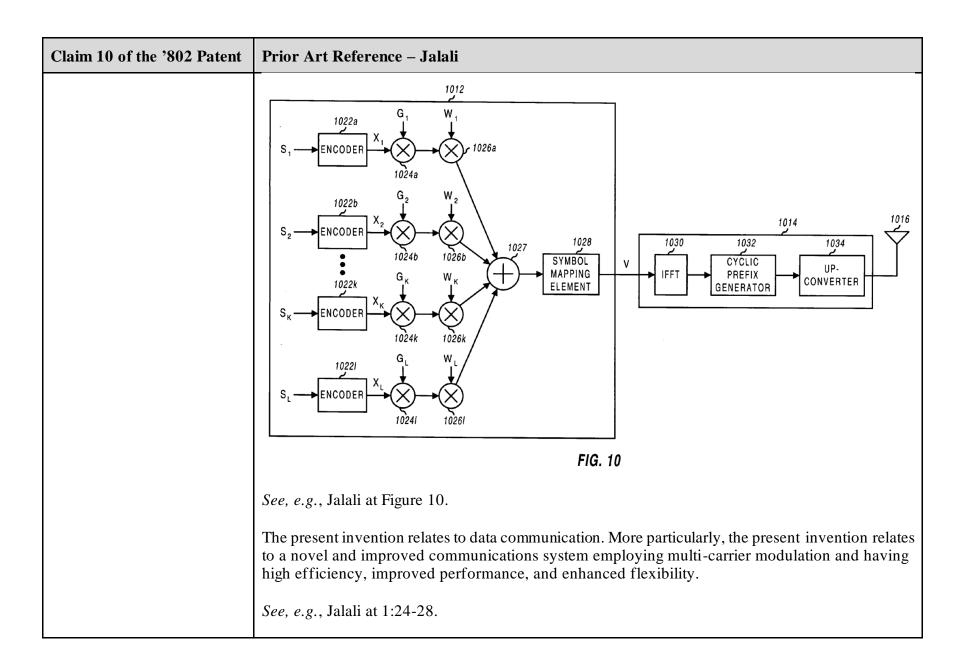
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.11] wherein the bandwidth of said power amplifier is greater than the difference between a lowest	Jalali discloses "wherein the bandwidth of said power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range." See, e.g.:
frequency in the first up- converted frequency range and a highest frequency in the second up-converted frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol
	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more







Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

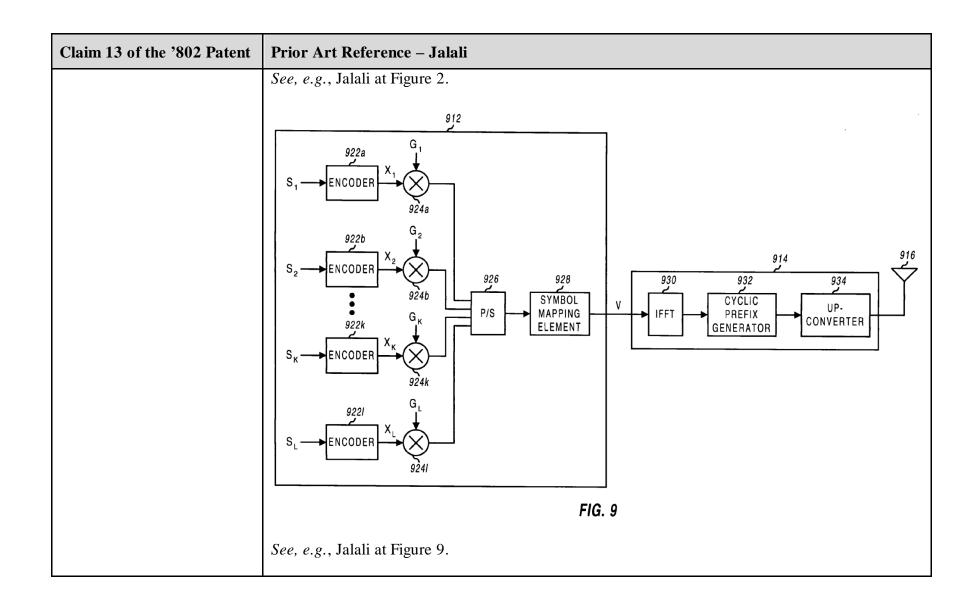
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

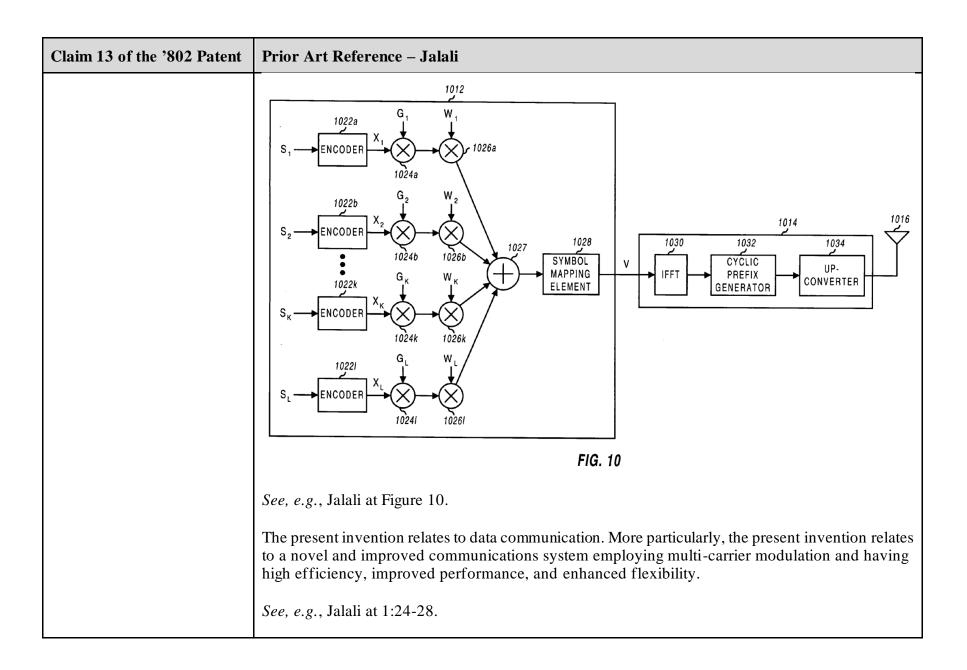
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
[13.1] The method of claim 10	Jalali discloses all the elements of claim 10 for all the reasons provided above.
[13.2] wherein the first digital signal is encoded using a first wireless protocol and the	Jalali discloses "wherein the first digital signal is encoded using a first wireless protocol and the second digital signal is encoded using a second wireless protocol." See, e.g.:
second digital signal is encoded using a second wireless protocol.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 13 of the '802 Patent	Prior Art Re	ference –	Jalali								
	from the code vector includ. The modulate transmission. "circuits". Easymbols, a nu symbols, or s Different circuperiods).  See, e.g., Jala	ing a set of or modulate. The data : ch circuit umber of t ome other cuits can b	es the mo from eac can be do ones from combinate used for	lues used odulations he coded defined to a single ation of to	to modu ymbol v lata strea include a OFDM ones. The data (e.	late a set ectors to am is maj a number symbol, e circuits	provide provide apped to a rof tones all tones can have	to general modular respective from a reference one control of the	ate an O ated sign we set of number of e or more ize or dif	FDM symlal suitable one or moof OFDM e OFDM	bol. for ore es.
	Freq			OFDIN SYMBOL							
	sub-channel 1		control -								ļ
	sub-channel 2	All of the time to	broadcast -								
	sub-channel 3 sub-channel 4		voice 1 —							-	
	sub-channel 5	· · · · · · · · · · · · · · · · · · ·	///////////////////////////////////////	Et et l		voice 3				-	
	sub-channel 6			W Takk	11.47			voice 4 —		-	
	sub-channel 7				I Tach	I a late					
	sub-channel 8	THE SERVER									
	sub-channel 9			(1) [ ] [ ] [ ]							
	sub-channel 10	1 1 2 4				I NET THE				data 5	
	sub-channel 11									data 5	
	sub-channel 12	***									
	sub-channel 13 sub-channel 14										
	sub-channel 15	37 MA									
	sub-channel 16	pilot	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6	
										<b>&gt;</b>	Time
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9	
					FIG	G. 2					
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Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

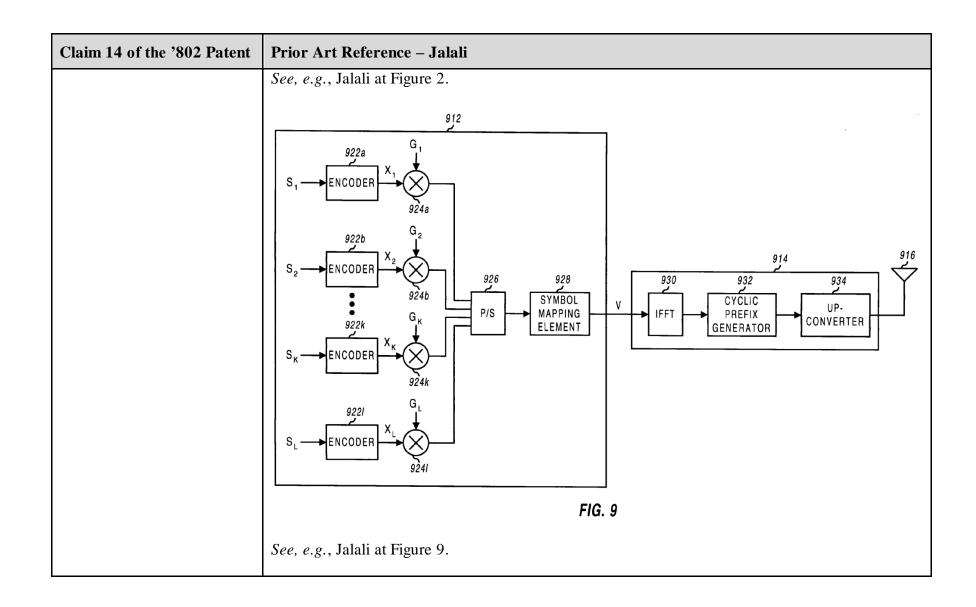
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

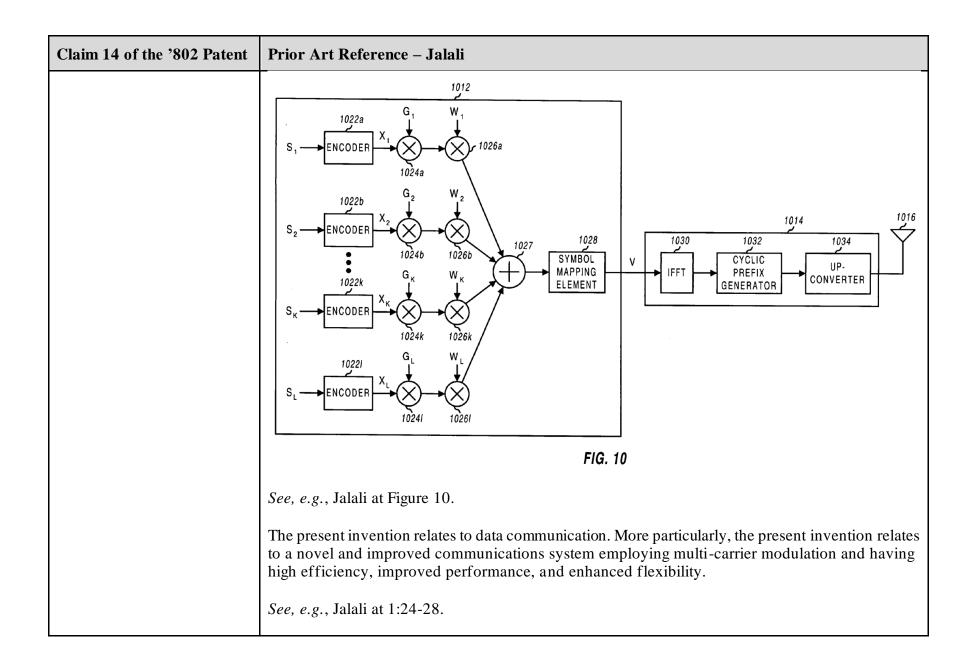
Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

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[14.1] The method of claim 10	Jalali discloses all the elements of claim 10 for all the reasons provided above.
[14.2] wherein the second data is the same as the first data, the method further	Jalali discloses "wherein the second data is the same as the first data, the method further comprising." See, e.g.:
comprising:	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

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	o-channel 11			14.1					. 5)	uata 9	
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sul	b-channel 16	pilot	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6	i
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9	Time
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					FIG	7. <i>L</i>					





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

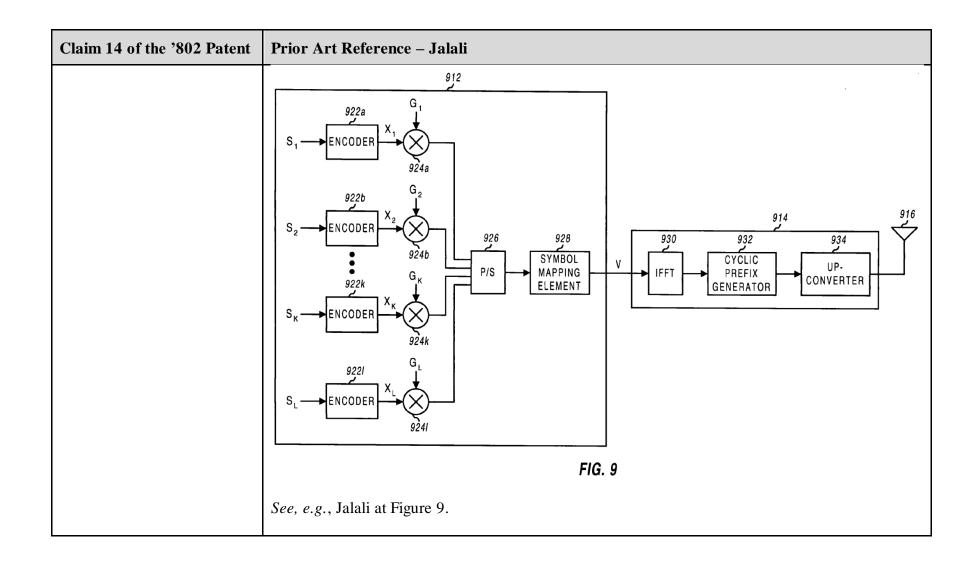
Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

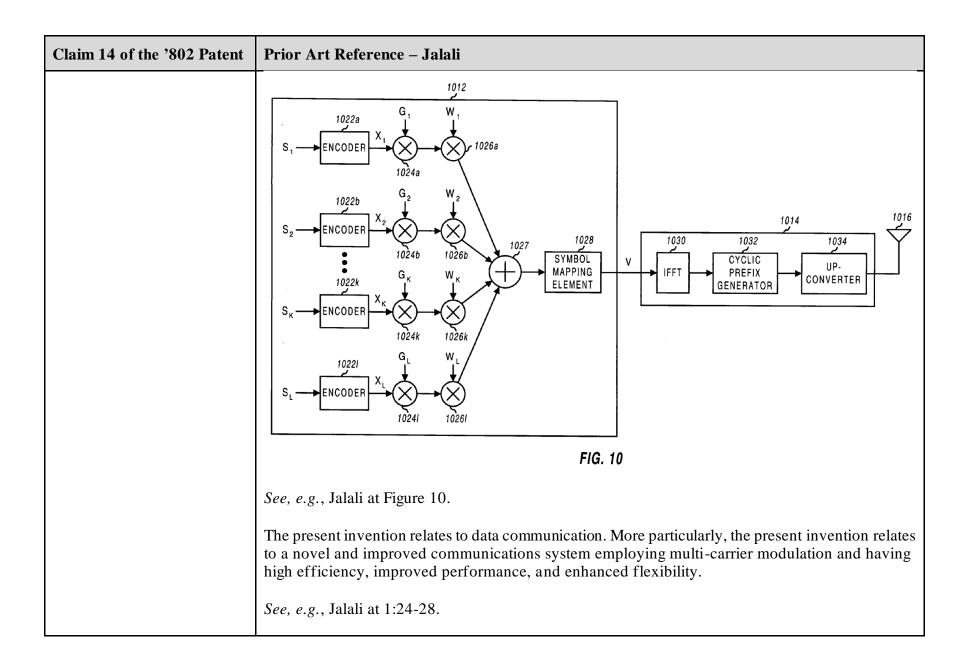
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.3] receiving the transmitted signal on a second	Jalali discloses "receiving the transmitted signal on a second antenna." See, e.g.:
antenna;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM

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	symbols, or so Different circu periods). See, e.g., Jalai	uits can b	e used fo								
	Frequency		-	OFDM symbol	<b>-</b>						
	sub-channel 1 🛕	av sidni	control -							<b></b>	
	sub-channel 2	我 一种离时	broadcast —							<b>-</b>	l
	sub-channel 3		voice 1 —								1
	sub-channel 4	William William	voice 2 —	THE RESERVE AND ADDRESS OF THE PERSON OF THE	185 S. 1862 Sept. 1853 Sept. 1853					<u> </u>	ł
	sub-channel 5	7 7 7		. # A		voice 3 —					ł
	sub-channel 6	14 - 15						voice 4 -			
	sub-channel 7	- 33			N. S						
	sub-channel 8										
	sub-channel 9 sub-channel 10	F-6.555-3-6									
	sub-channel 11	# 1 A								data 5	
	sub-channel 12			an Mari							
	sub-channel 13	¥ L		4 4 4					1.		
	sub-channel 14										
	sub-channel 15	1 1 1 1 1 1 1		di' ta j							
	sub-channel 16	pilot 4	data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6	J
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9	- Time
					FIG	G. 2					
	See, e.g., Jala	li at Figur	e 2.								





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

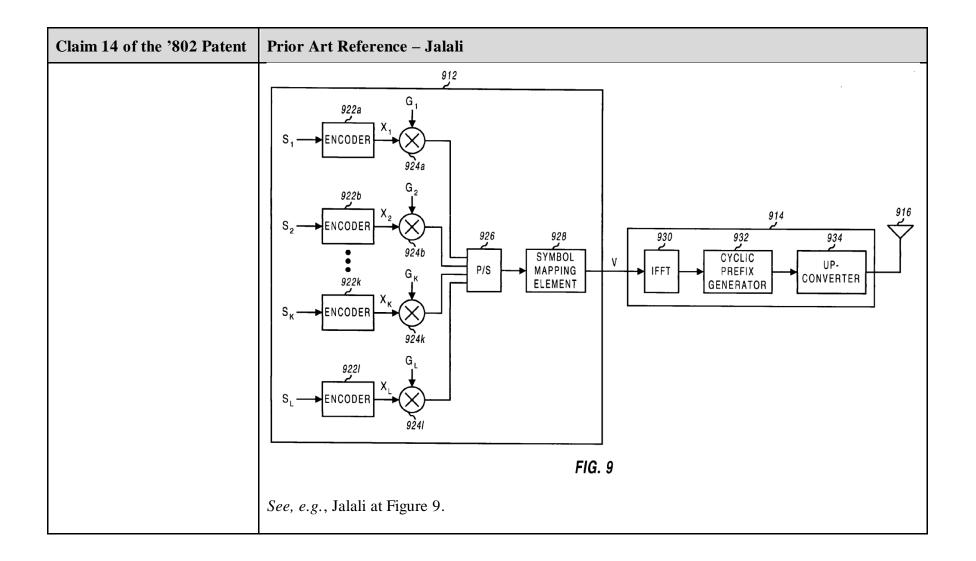
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

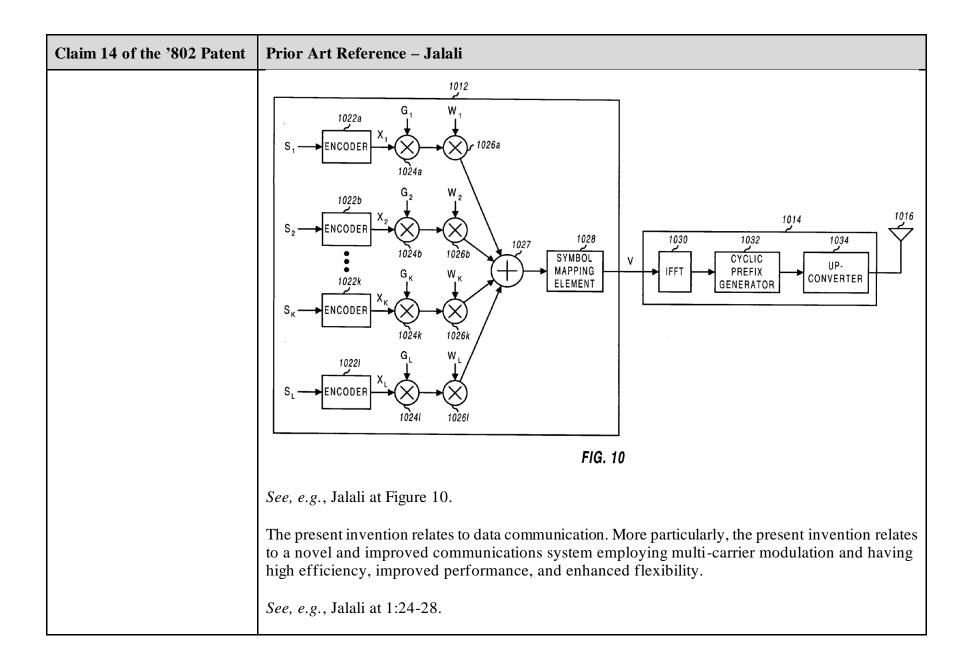
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.4] amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal,	Jalali discloses "amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal, wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the first up-converted frequency range and the highest frequency in the second up-converted frequency range." See, e.g.:
wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the first up-converted frequency range and the highest frequency in the second up- converted frequency range;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

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	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ◀──
	sub-channel 1 sub-channel 2 sub-channel 3 sub-channel 4 sub-channel 5 sub-channel 6 sub-channel 7 sub-channel 8 sub-channel 10 sub-channel 11 sub-channel 12 sub-channel 13 sub-channel 14
	sub-channel 15 sub-channel 16  pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Time
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

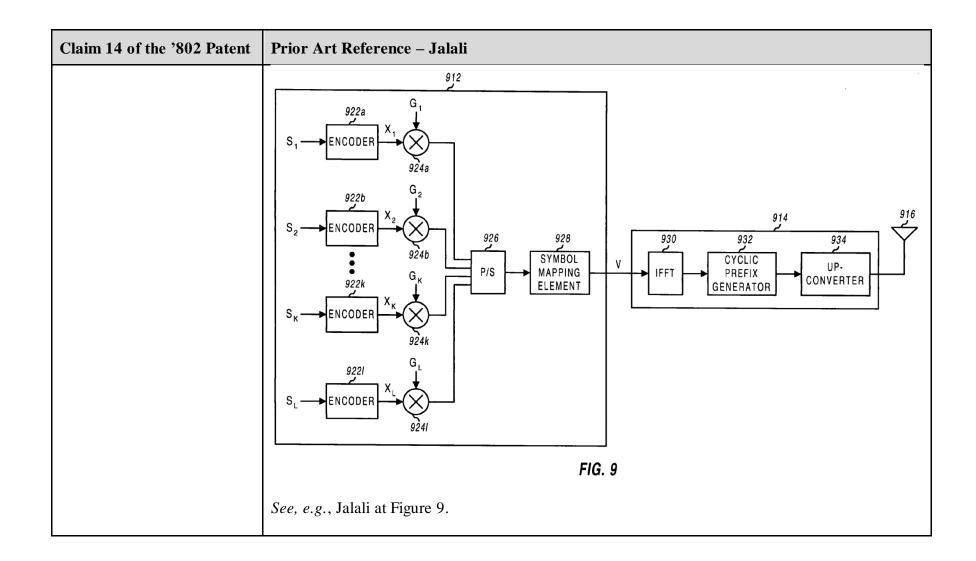
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

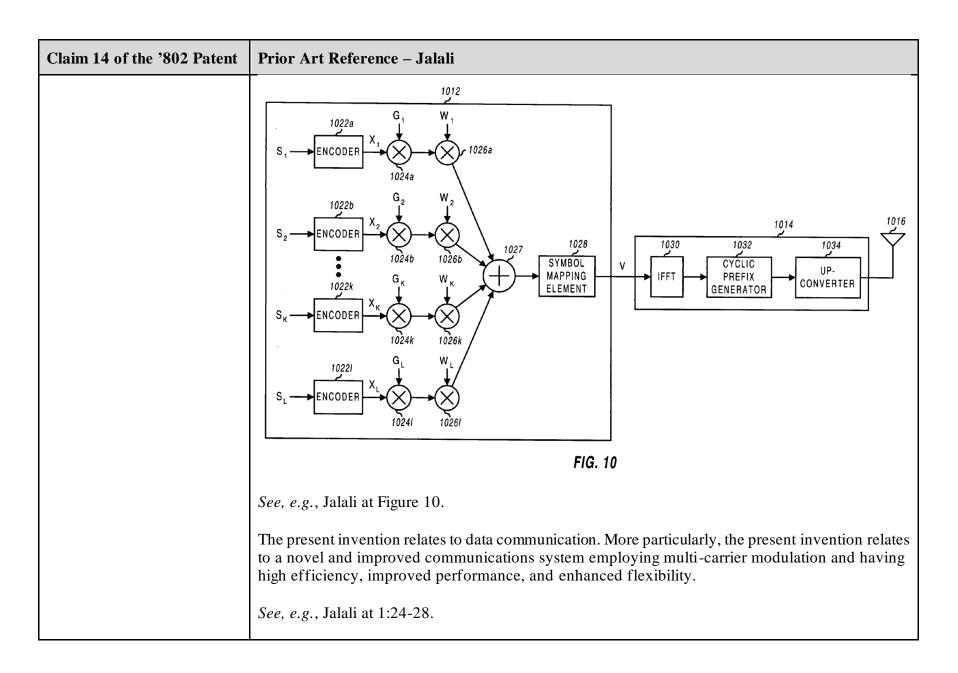
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.5] down-converting the amplified received upconverted signal using a first	Jalali discloses "down-converting the amplified received up-converted signal using a first down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal corresponding to the first analog signal." See, e.g.:
down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal corresponding to the first analog signal; and	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀─
	sub-channel 1 ♠ Fig. 3.4.1.1 control →
	sub-channel 2 broadcast
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5
	sub-channel 6 sub-channel 7
	sub-channel 8
	sub-channel 9
	sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15 sub-channel 16 pilot 4 data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	Sub-Citatino 10
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

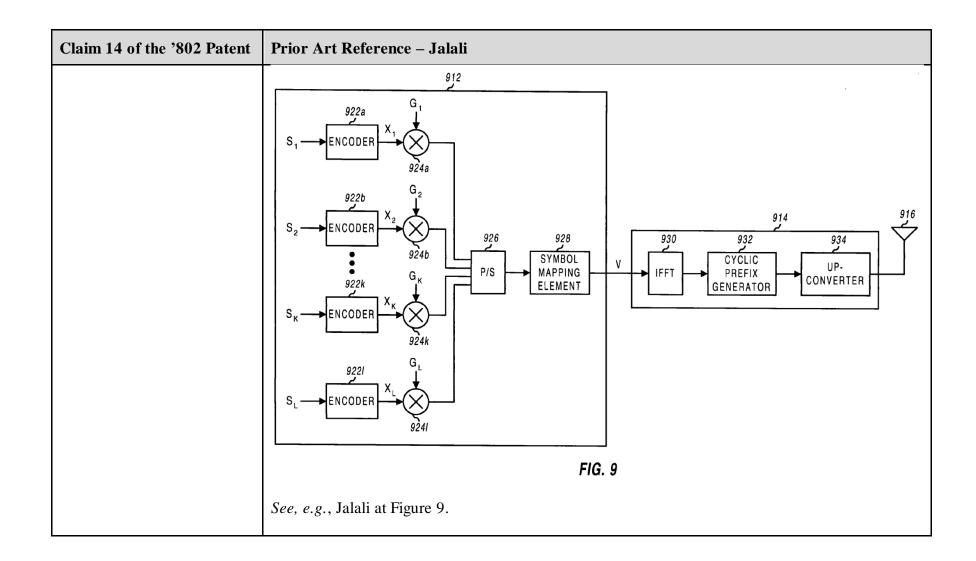
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

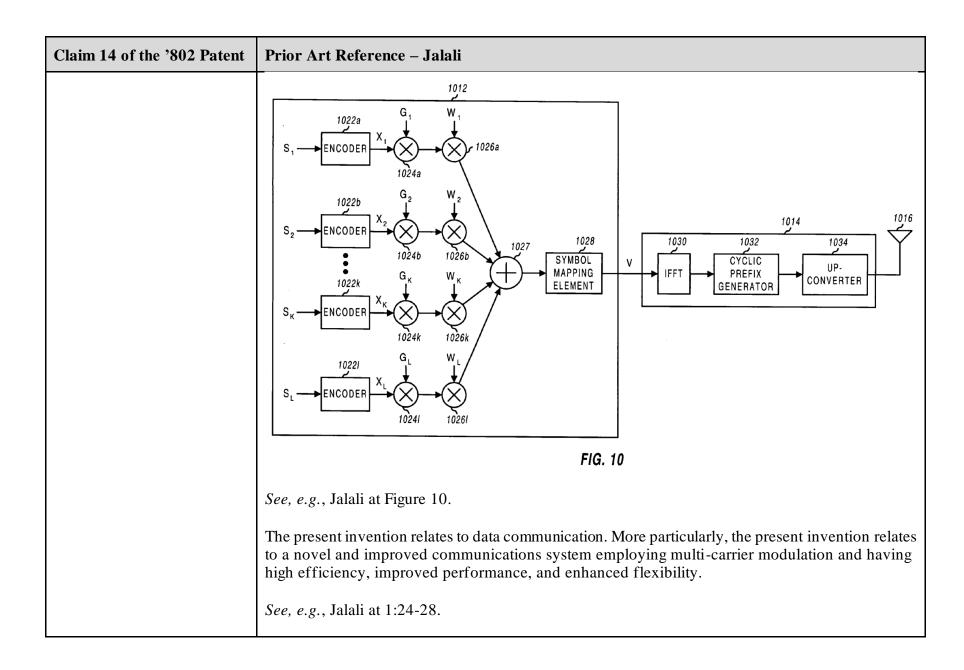
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.6] down-converting the amplified received upconverted analog signal using a second down-converter and	Jalali discloses "down-converting the amplified received up-converted analog signal using a second down-converter and a signal corresponding to the second RF center frequency to produce a fifth analog signal corresponding to the second analog signal." See, e.g.:
a signal corresponding to the second RF center frequency to produce a fifth analog signal corresponding to the second analog signal.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.
	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀
	sub-channel 1 ♠ 🚉 🚎 🚉 control 🔸
	sub-channel 2 broadcast -
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5 voice 3
	sub-channel 6 voice 4
	sub-channel 7
	sub-channel 8
	sub-channel 9 sub-channel 10
	sub-channel 11
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Time
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

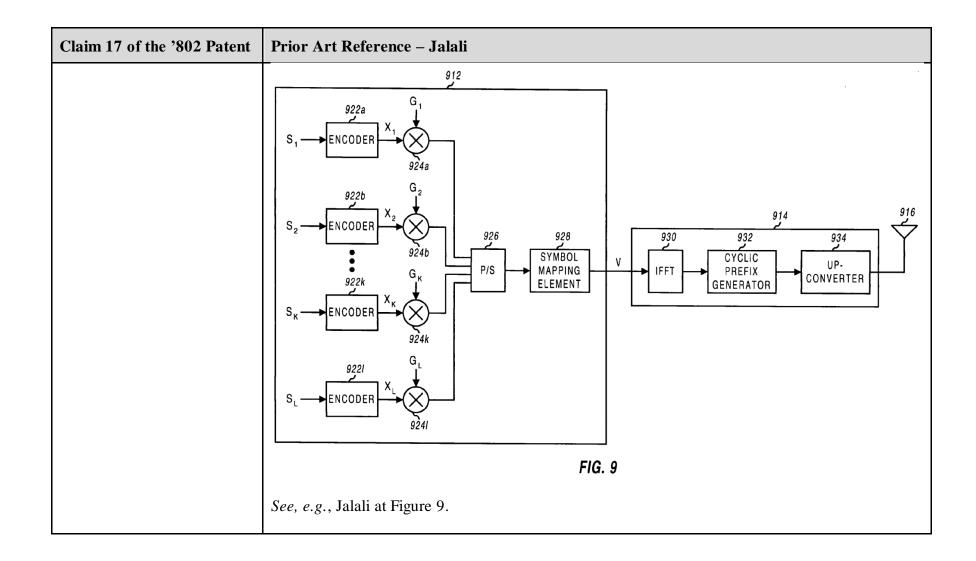
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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

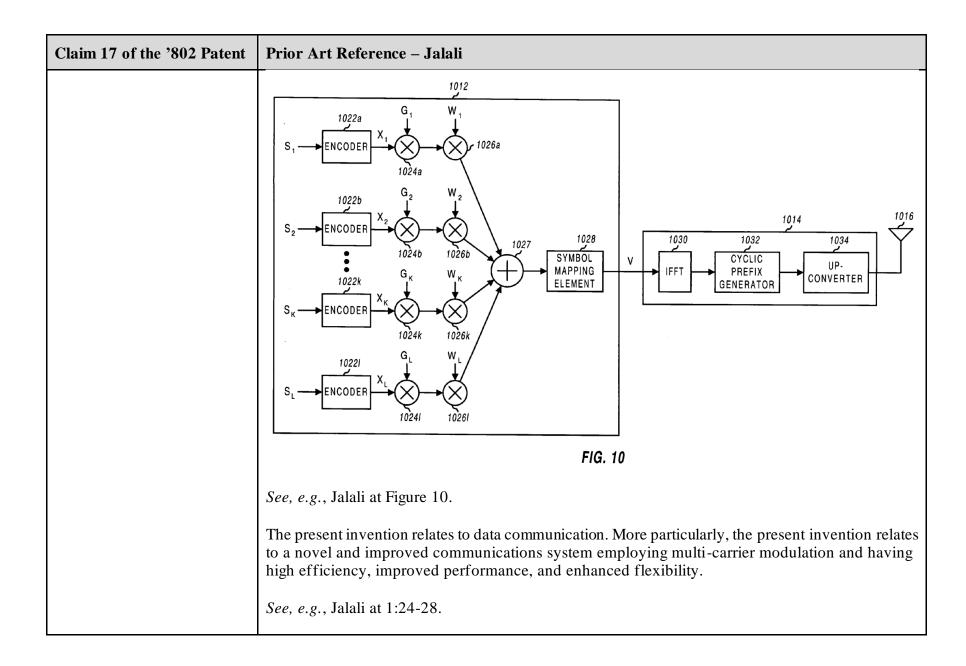
Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
[17.1] A wireless communication system comprising:	To the extent the preamble is limiting, Jalali discloses "A wireless communication system comprising." See, e.g.:
	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.2] a baseband digital system for providing a first digital signal comprising a	Jalali discloses "a baseband digital system for providing a first digital signal comprising a first data to be transmitted and a second digital signal comprising a second data to be transmitted." See, e.g.:
first data to be transmitted and a second digital signal comprising a second data to be transmitted;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

Claim 17 of the '802 Patent	Prior Art Reference – Jalali	
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silene periods).	
	See, e.g., Jalali at Abstract.	
	OFDM symbol ◀	
	sub-channel 1 ♣ Provided Control →	
	sub-channel 2	
	sub-channel 3 voice 1 ▶	
	sub-channel 4 voice 2	
	sub-channel 5 voice 3	
	sub-channel 6 voice 4	
	sub-channel 7	
	sub-channel 8	
	sub-channel 9 sub-channel 10	
	sub-channel 11 data 5	
	sub-channel 12	
	sub-channel 13	
	sub-channel 14	
	sub-channel 15	
	sub-channel 16 pilot A data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6	
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9	me
	FIG. 2	
	See, e.g., Jalali at Figure 2.	





Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

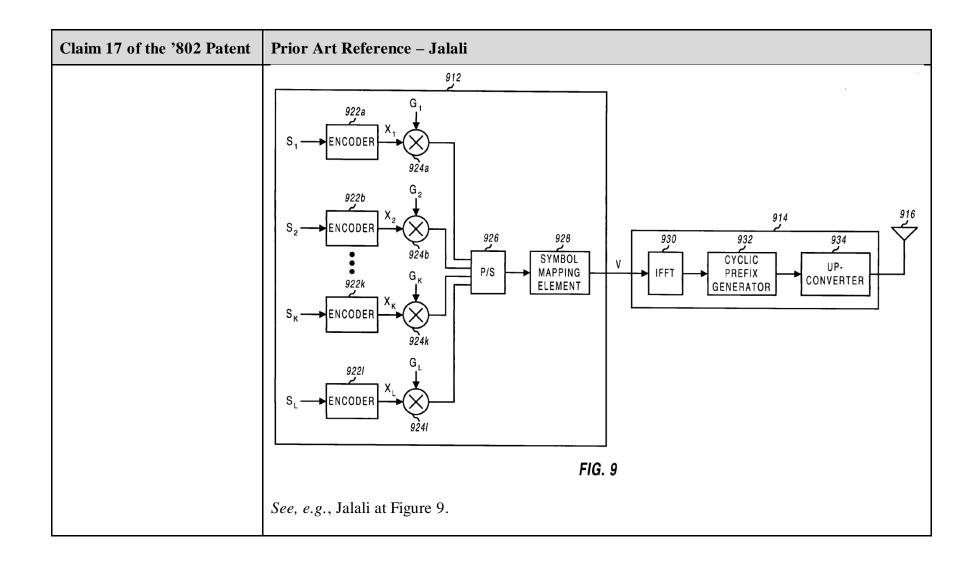
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

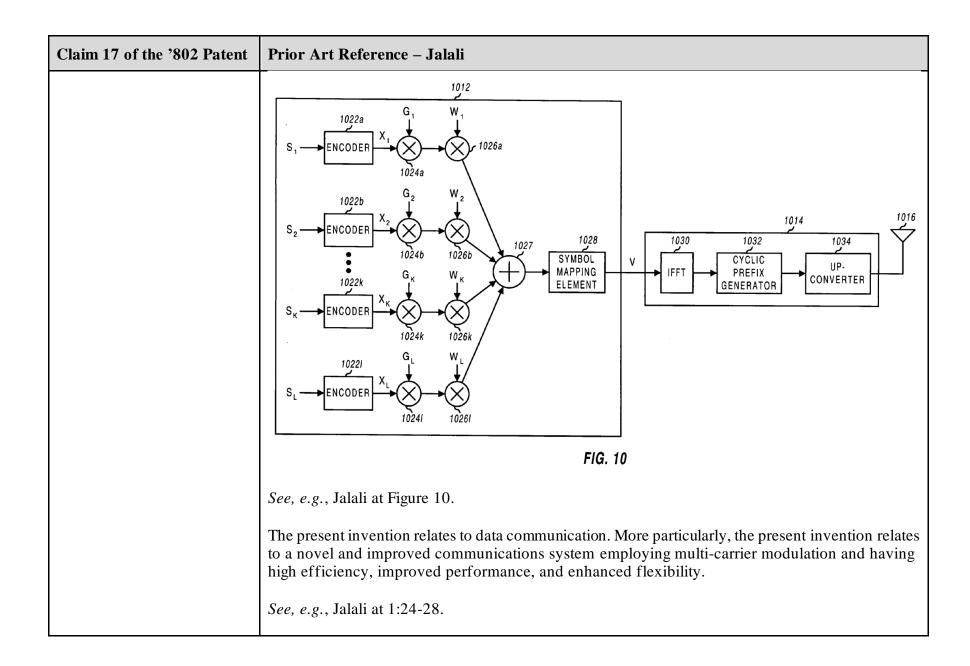
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.3] a first digital-to-analog converter for receiving the first digital signal and converting the first digital	Jalali discloses "a first digital-to-analog converter for receiving the first digital signal and converting the first digital signal into a first analog signal, the first analog signal carrying the first data across a first frequency range." See, e.g.:
signal into a first analog signal, the first analog signal carrying the first data across a first frequency range;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silenc periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀
	sub-channel 1 A control
	sub-channel 2 broadcast -
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5 voice 3 voice 4
	Sub-chainlei 0
	sub-channel 7 sub-channel 8
	sub-channel 9
	sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	FIG. 2
	See, e.g., Jalali at Figure 2.





Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

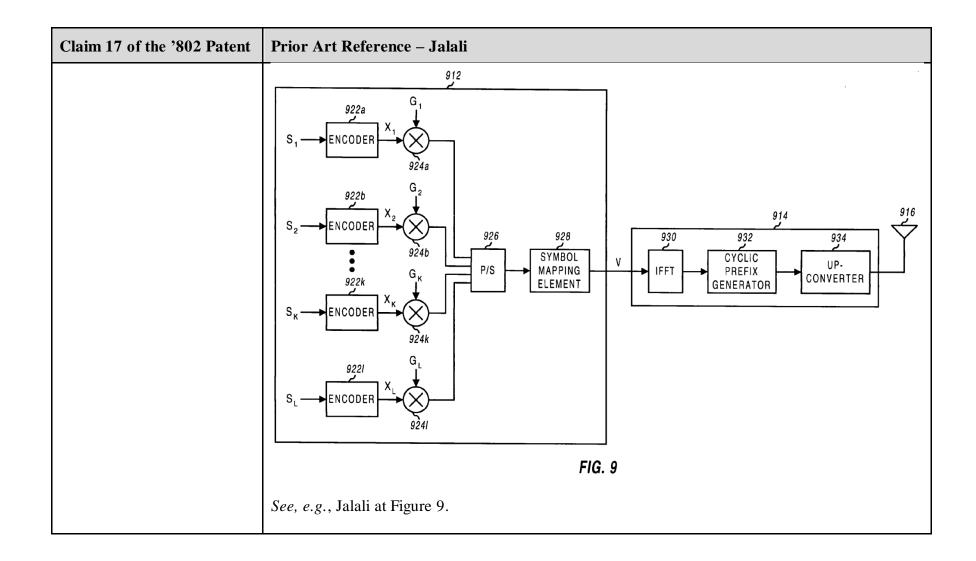
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

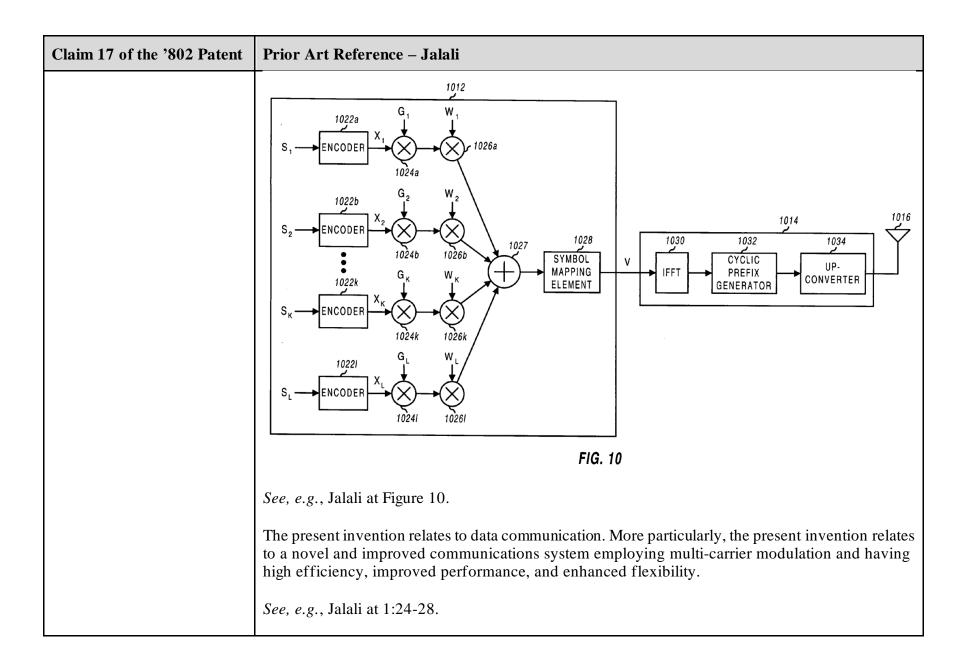
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.4] a second digital-to- analog converter for receiving the second digital signal and	Jalali discloses "a second digital-to-analog converter for receiving the second digital signal and converting the second digital signal into a second analog signal, the second analog signal carrying the second data across a second frequency range." See, e.g.:
converting the second digital signal into a second analog signal, the second analog signal carrying the second data across a second frequency range;	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silen periods).  See, e.g., Jalali at Abstract.	
	see, e.g., valair at riostraet.	
	OFDM symbol ◀──	
	sub-channel 1 ↑ control →	
	sub-channel 2 broadcast	
	sub-channel 3 voice 1	
	sub-channel 4 voice 2	
	sub-channel 5	
	sub-channel 6 sub-channel 7	
	sub-channel 8	
	sub-channel 9	
	sub-channel 10	
	sub-channel 11 data 5	
	sub-channel 12	
	sub-channel 13	
	sub-channel 14	
	sub-channel 15 sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6	
	Sub-Chairmen To	T:
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9	Ime
	FIG. 2	
	See, e.g., Jalali at Figure 2.	





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

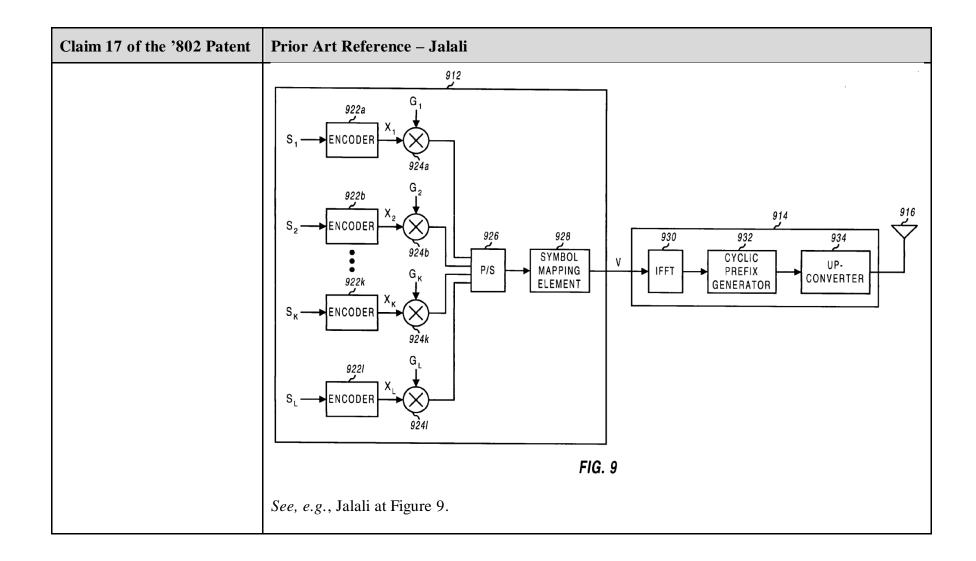
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

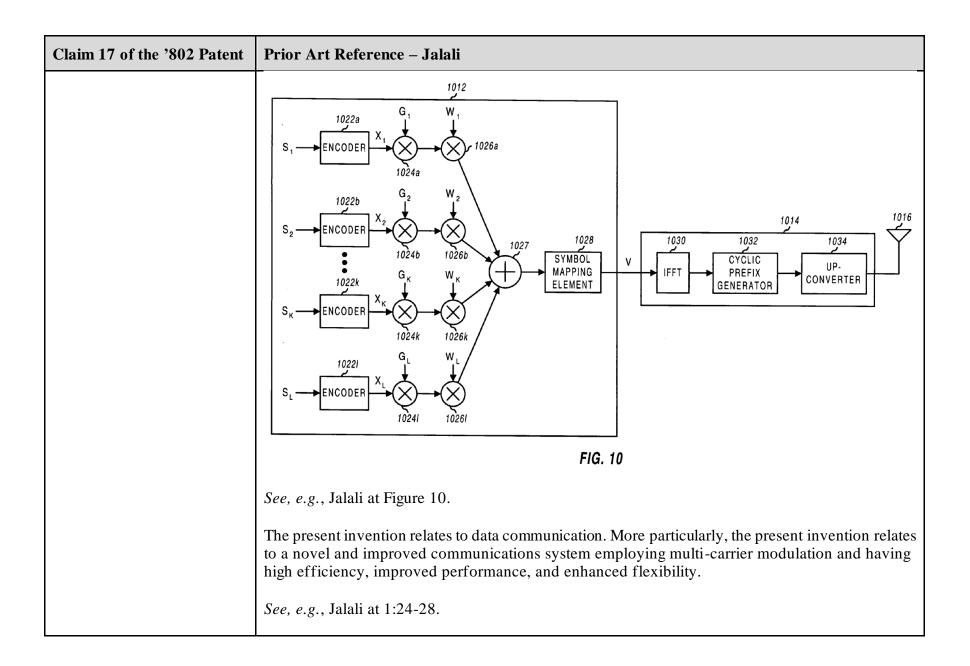
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.5] a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a	Jalali discloses "a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a first RF frequency, wherein the first up-converter outputs a first up-converted analog signal comprising a first up-converted frequency range from the first RF frequency minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range." See, e.g.:
first RF frequency, wherein the first up-converter outputs a first up-converted analog	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream
signal comprising a first up- converted frequency range from the first RF frequency	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.

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minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range;	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	order at Nostract.  → OFDM symbol ←
	sub-channel 1       sub-channel 2         sub-channel 3       sub-channel 4         sub-channel 4       voice 1         sub-channel 5       sub-channel 6         sub-channel 7       sub-channel 8         sub-channel 9       sub-channel 10         sub-channel 11       data 5         sub-channel 12       sub-channel 13         sub-channel 14       sub-channel 15         sub-channel 15       pilot       data 2       data 2       data 3       data 1       data 4       data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9   FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.6] a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF	Jalali discloses "a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF frequency, wherein the second up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.:
frequency, wherein the second up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

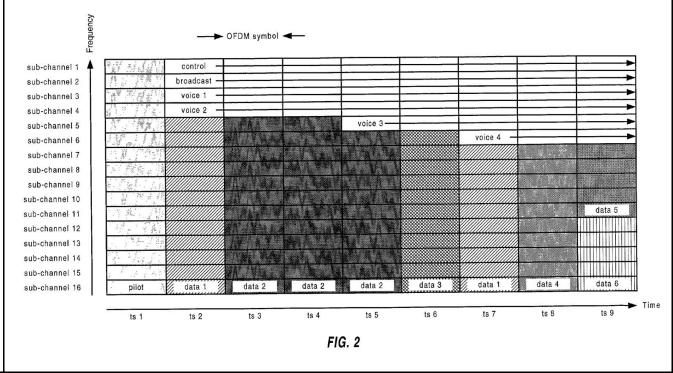
## Claim 17 of the '802 Patent

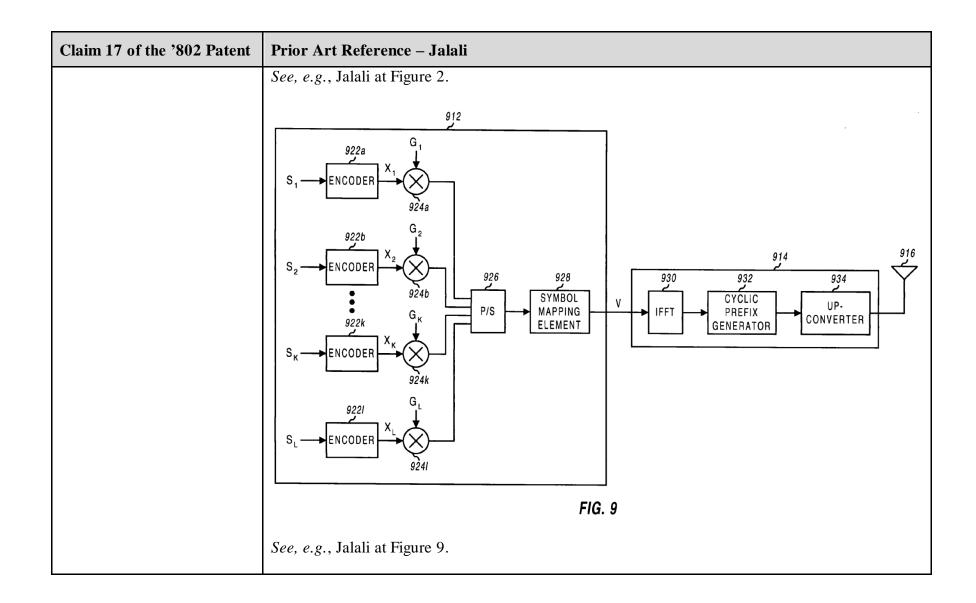
from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range; and

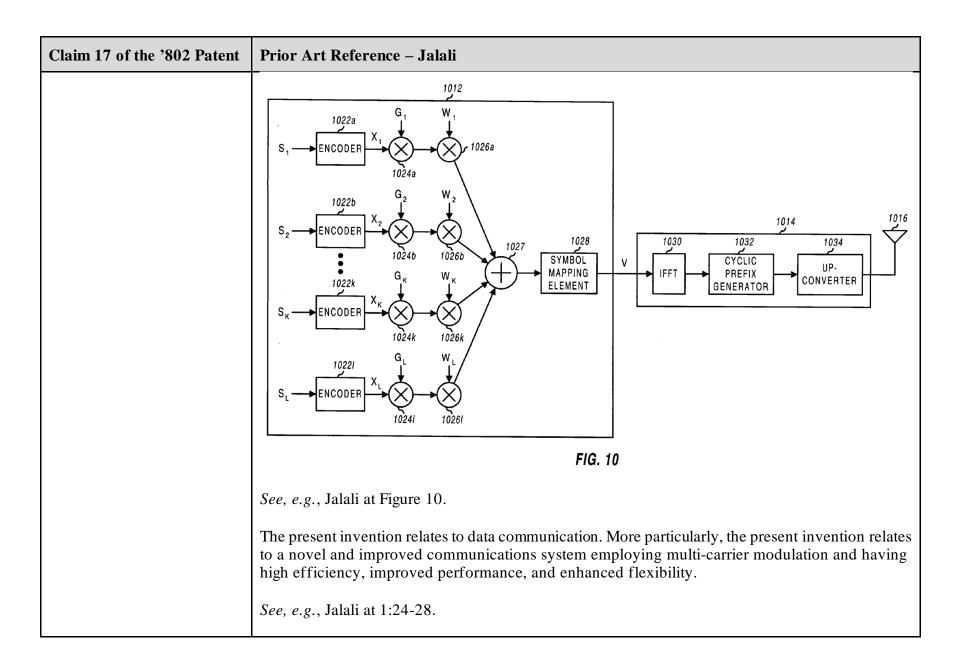
## **Prior Art Reference – Jalali**

from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).

See, e.g., Jalali at Abstract.







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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

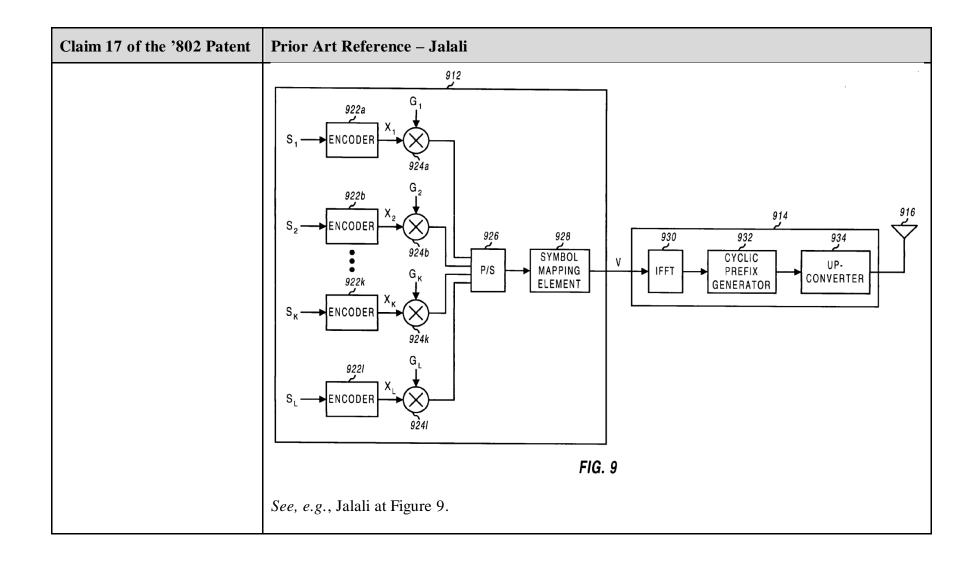
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

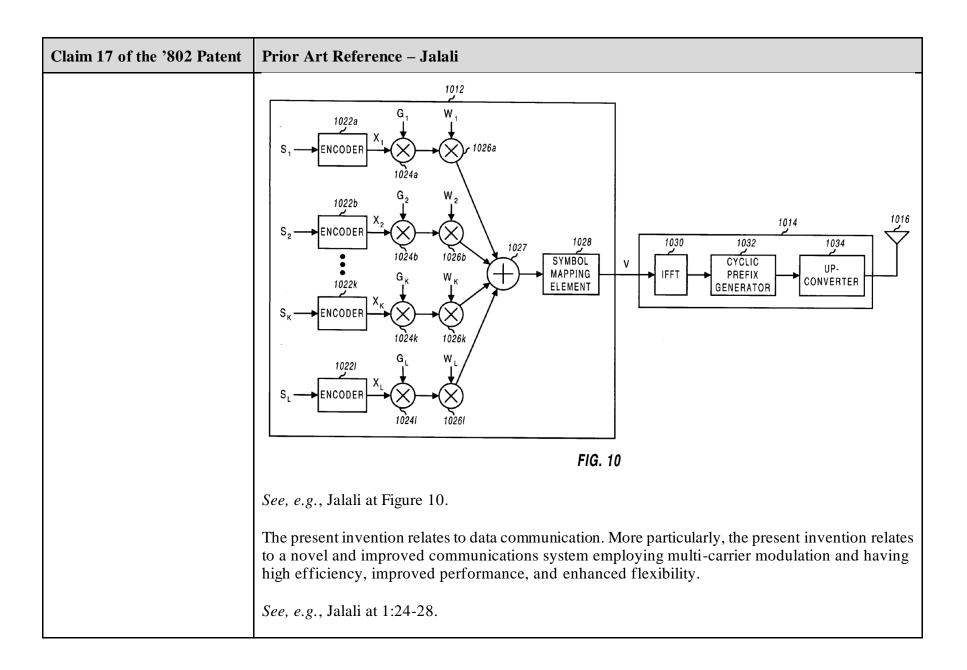
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.7] a power amplifier coupled to receive the first and second up-converted analog signals, wherein the	Jalali discloses "a power amplifier coupled to receive the first and second up-converted analog signals, wherein the bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range." See, e.g.:
bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first upconverted frequency range and a highest frequency in the second up-converted frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

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	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).
	See, e.g., Jalali at Abstract.
	OFDM symbol ◀──
	sub-channel 1 sub-channel 2 sub-channel 3 sub-channel 3
	sub-channel 4 sub-channel 5 sub-channel 6 voice 2 voice 3 voice 4
	sub-channel 7 sub-channel 8
	sub-channel 9 sub-channel 10 sub-channel 11 sub-channel 12
	sub-channel 13 sub-channel 14 sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

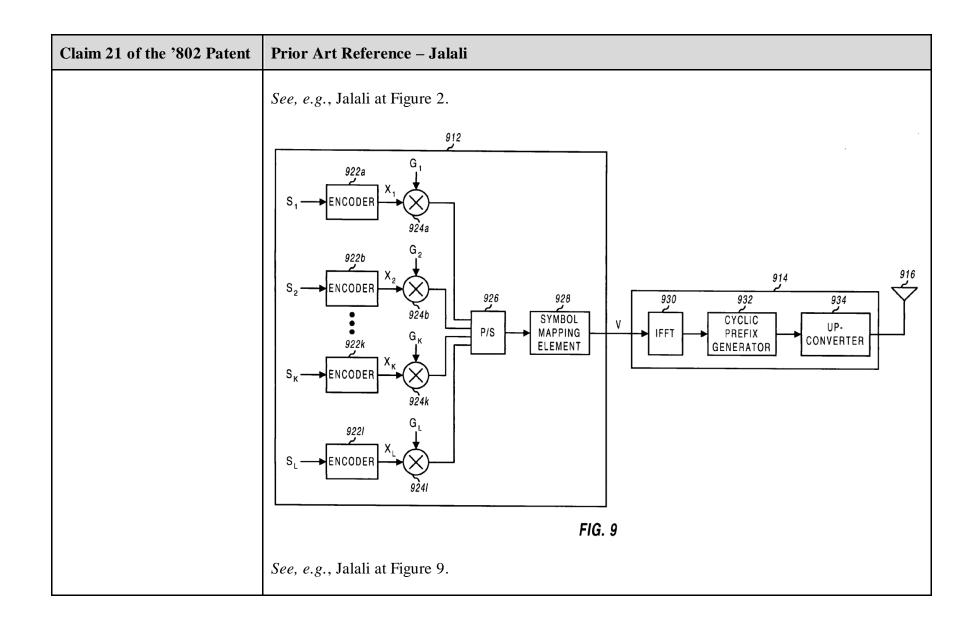
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

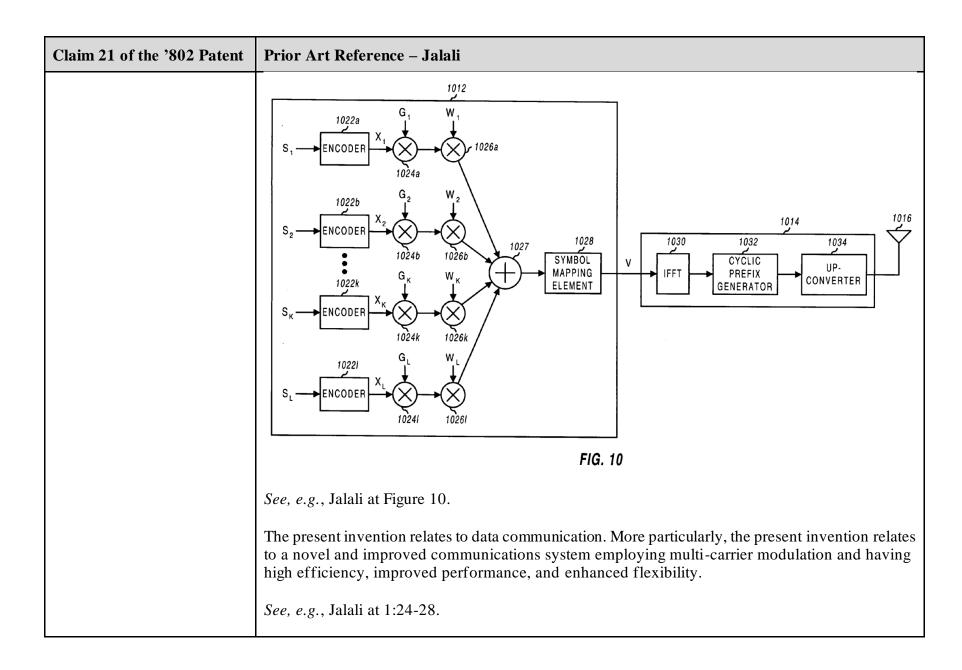
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
[21.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[21.2] wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of	Jalali discloses "wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of the second digital signal is encoded using a second wireless protocol." See, e.g.:
the second digital signal is encoded using a second wireless protocol.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀─
	sub-channel 2 broadcast
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5 voice 3
	sub-channel 6 voice 4 voice 4
	sub-channel 7
	sub-channel 8
	sub-channel 9 sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15
	sub-channel 16 pilot data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Time
	FIG. 2





Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

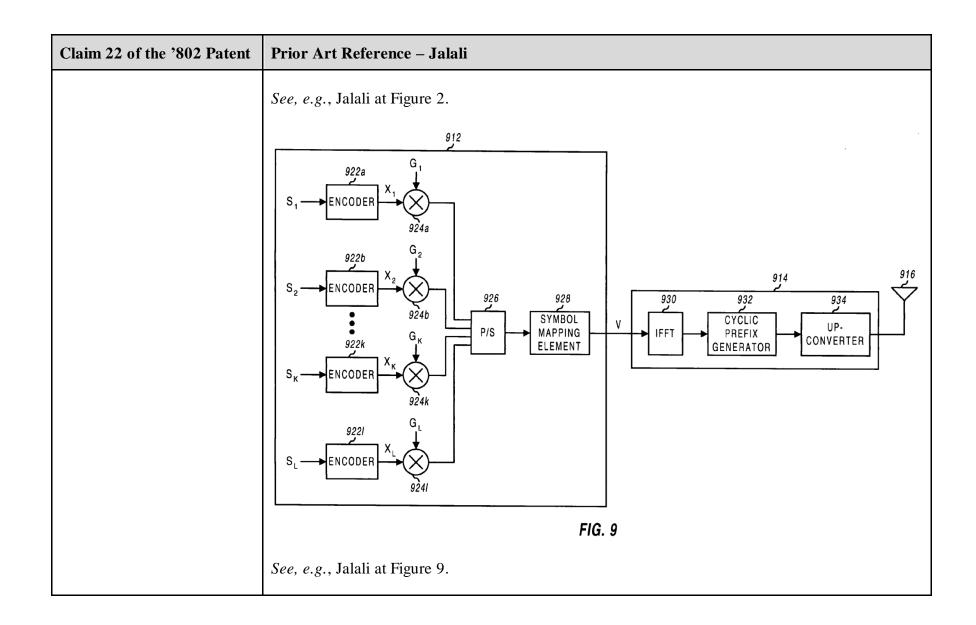
Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

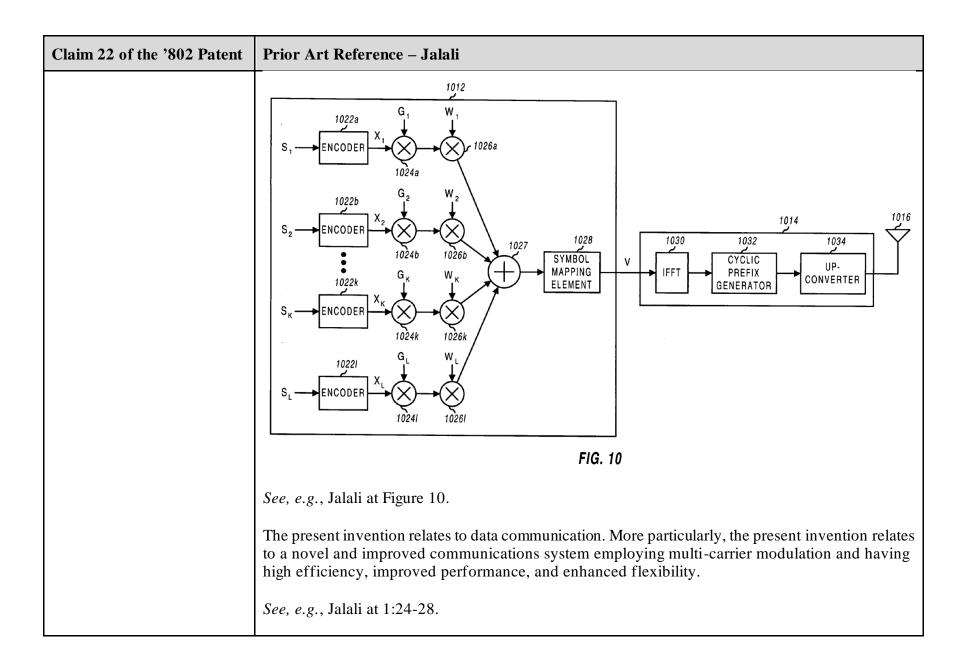
Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
[22.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[22.2] wherein the second data corresponds to the first data and wherein the power amplifier outputs a third up-	Jalali discloses "wherein the second data corresponds to the first data and wherein the power amplifier outputs a third up-converted signal comprising the up-converted first analog signal and the up-converted second analog signal." See, e.g.:
converted signal comprising the up-converted first analog	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
signal and the up-converted second analog signal.	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	sub-channel 1 ♣ ∰ ### #### control ♣
	sub-channel 2 broadcast
	sub-channel 3 sub-channel 4 voice 1 voice 2
	sub-channel 4 sub-channel 5 voice 2 voice 3
	sub-channel 6 voice 4
	sub-channel 7
	sub-channel 8
	sub-channel 9
	sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13 sub-channel 14
	sub-channel 15
	sub-channel 16 pilot 4 data 1 data 2 data 2 data 2 data 3 data 1 data 4 data 6
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9
	FIG. 2





Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

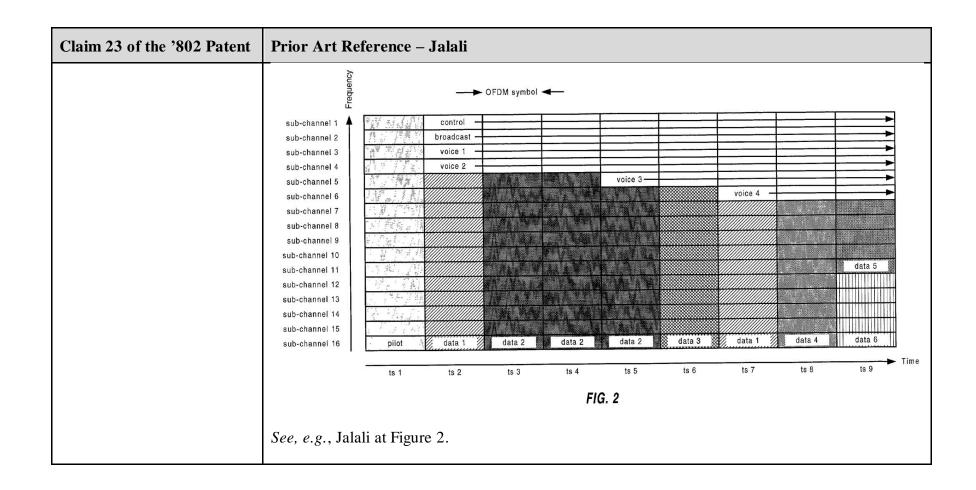
Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

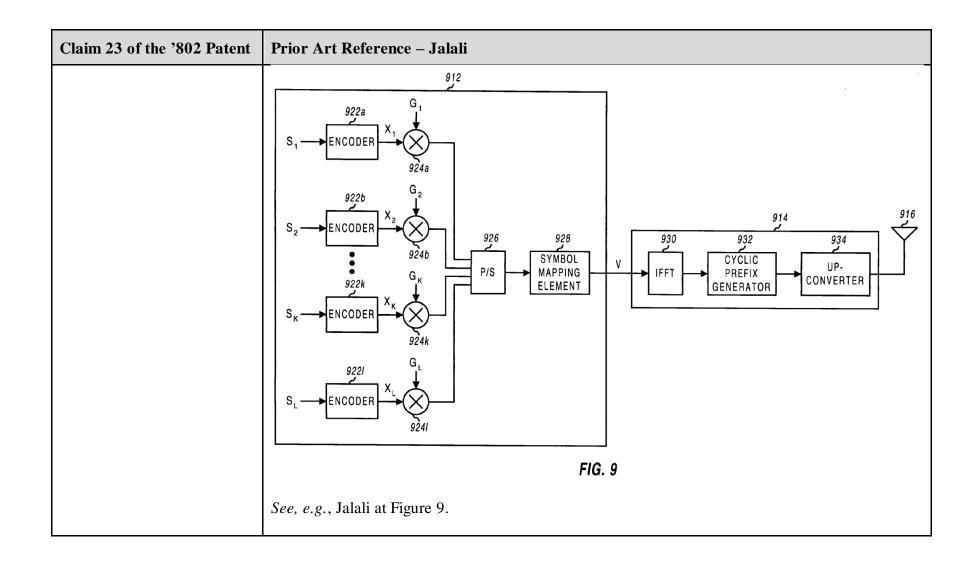
Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

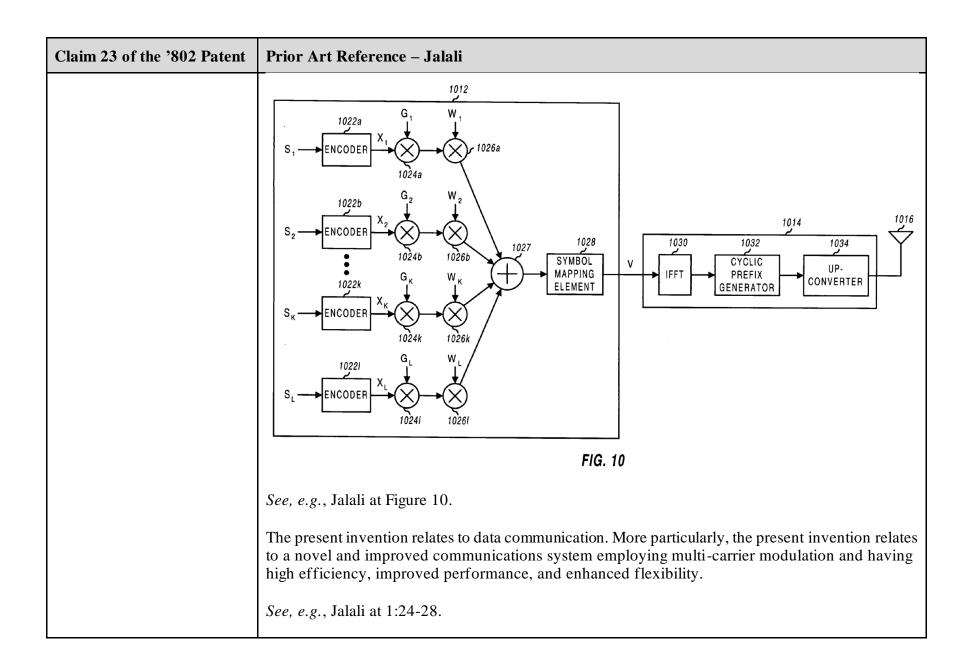
Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
[23.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[23.2] wherein first and	Jalali discloses "wherein first and second data to be transmitted comprise a plurality of OFDM
second data to be transmitted	symbols, wherein a first symbol is transmitted during a first time slot across the first up-converted
comprise a plurality of OFDM	frequency range and a second symbol is transmitted during the first time slot across the second up-
symbols, wherein a first	converted frequency range, and wherein a third symbol is transmitted during a second time slot
symbol is transmitted during a	across the first up-converted frequency range and a fourth symbol is transmitted during the second
first time slot across the first	time slot across a second up-converted frequency range." See, e.g.:
up-converted frequency range	

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
and a second symbol is transmitted during the first time slot across the second up-converted frequency range, and wherein a third symbol is transmitted during a second time slot across the first up-converted frequency range and a fourth symbol is transmitted during the second time slot across a second up-converted frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.







Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

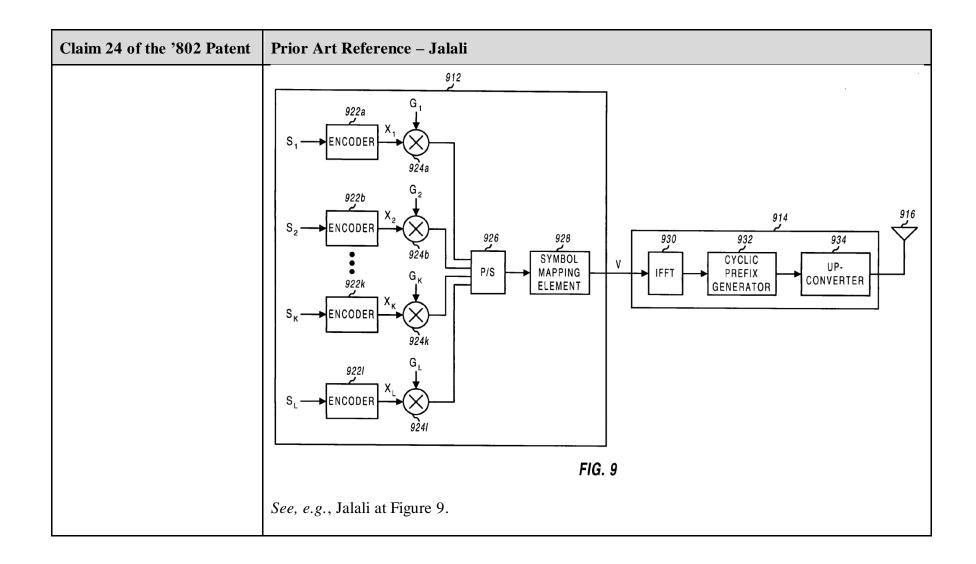
Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

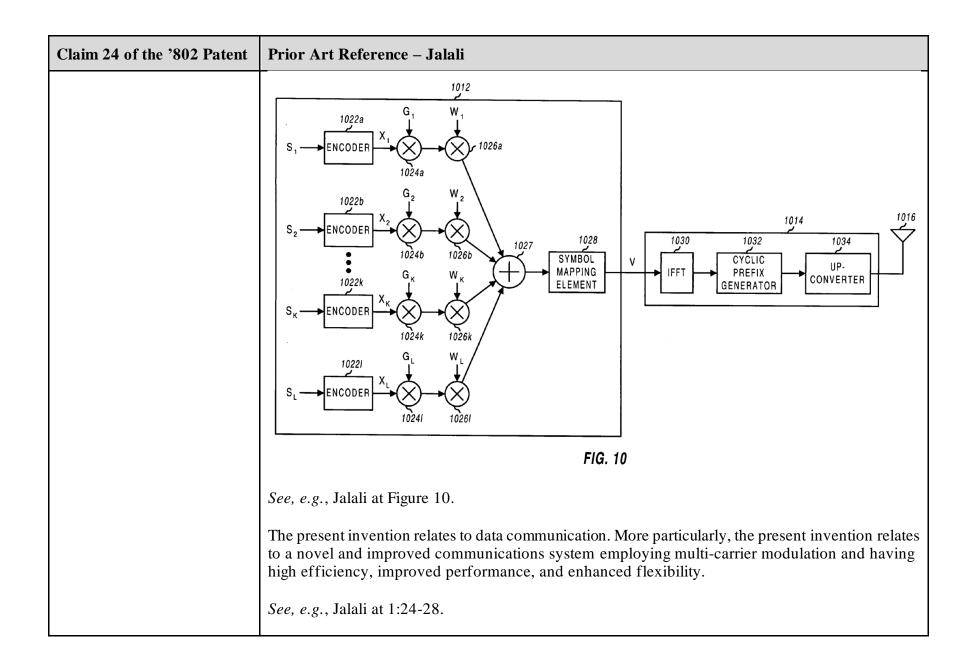
Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
[24.1] An electronic circuit comprising:	To the extent the preamble is limiting, Jalali discloses "An electronic circuit comprising." See, e.g.:
	Transmitter and receiver units for use in an OFDM communications system and configurable to
	support multiple types of services. The transmitter unit includes one or more encoders, a symbol
	mapping element, and a modulator. Each encoder receives and codes a respective channel data stream
	to generate a corresponding coded data stream. The symbol mapping element receives and maps data
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol
	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.

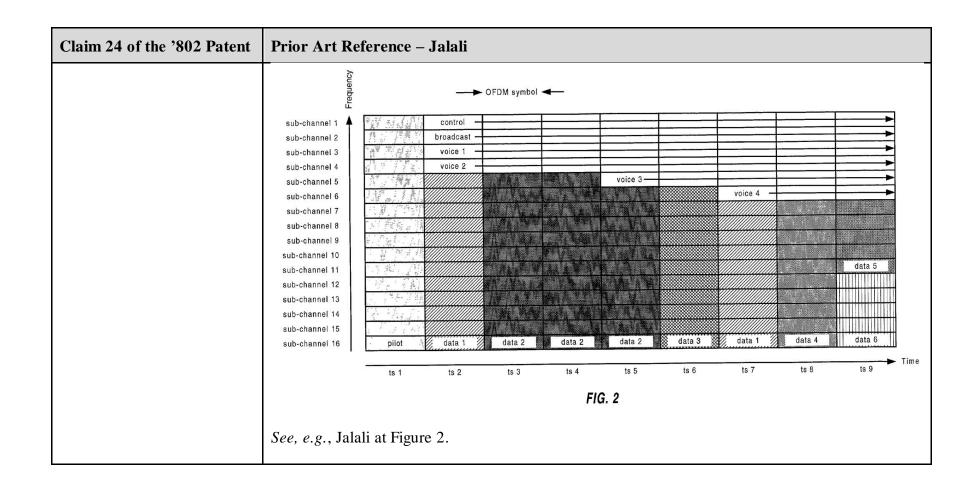
## 

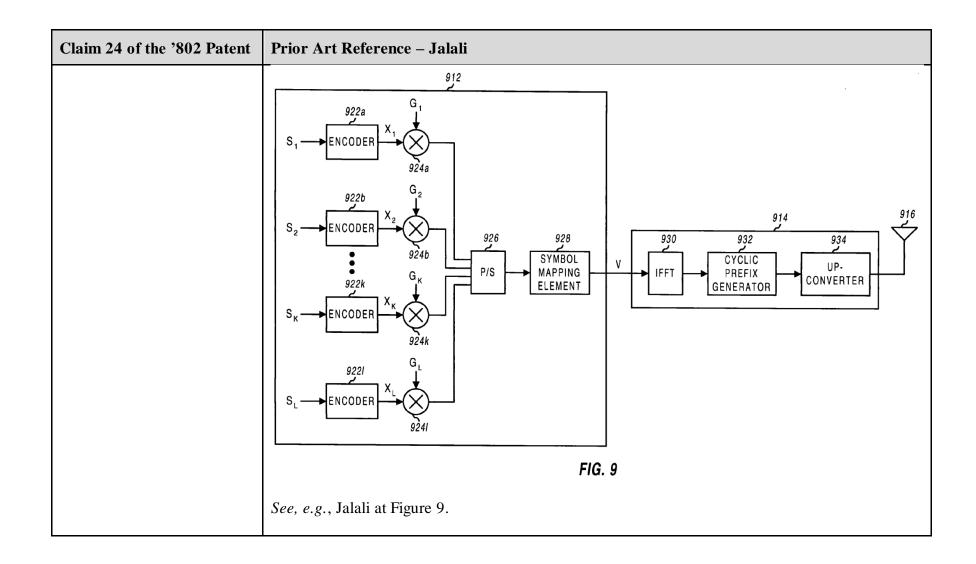
Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.

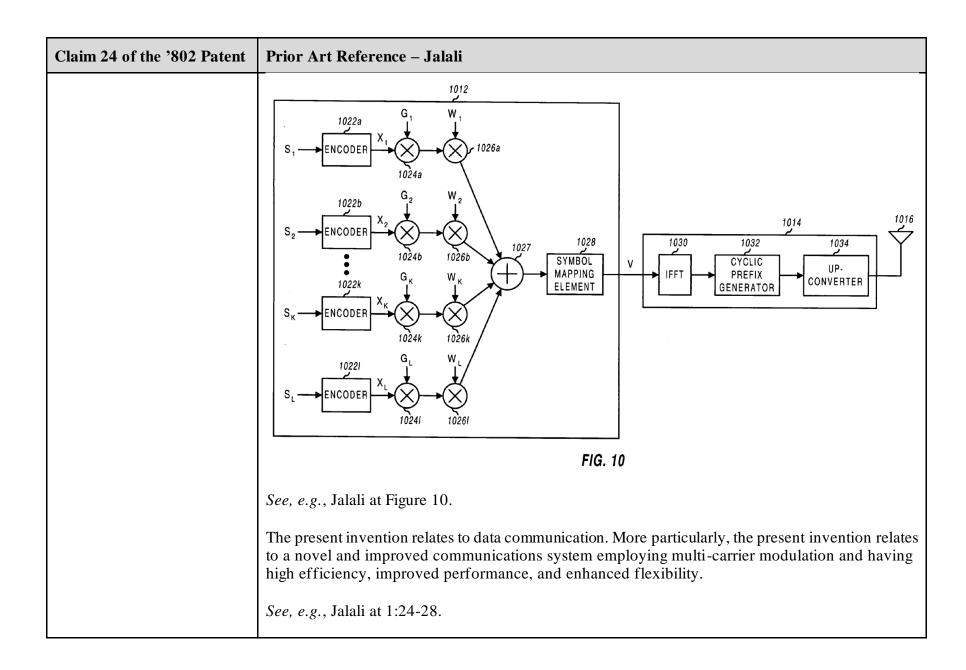




Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.2] a first down-converter circuit having a first input coupled to receive a first upconverted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted signal on the first down-converter output;	Jalali discloses "a first down-converter circuit having a first input coupled to receive a first upconverted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted signal on the first down-converter output." See, e.g.:  Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.







Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

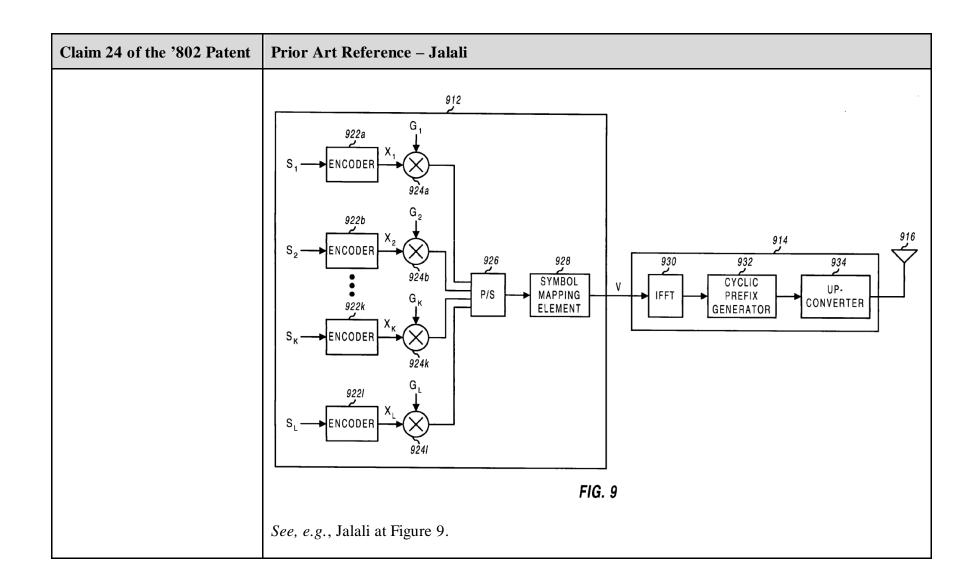
Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

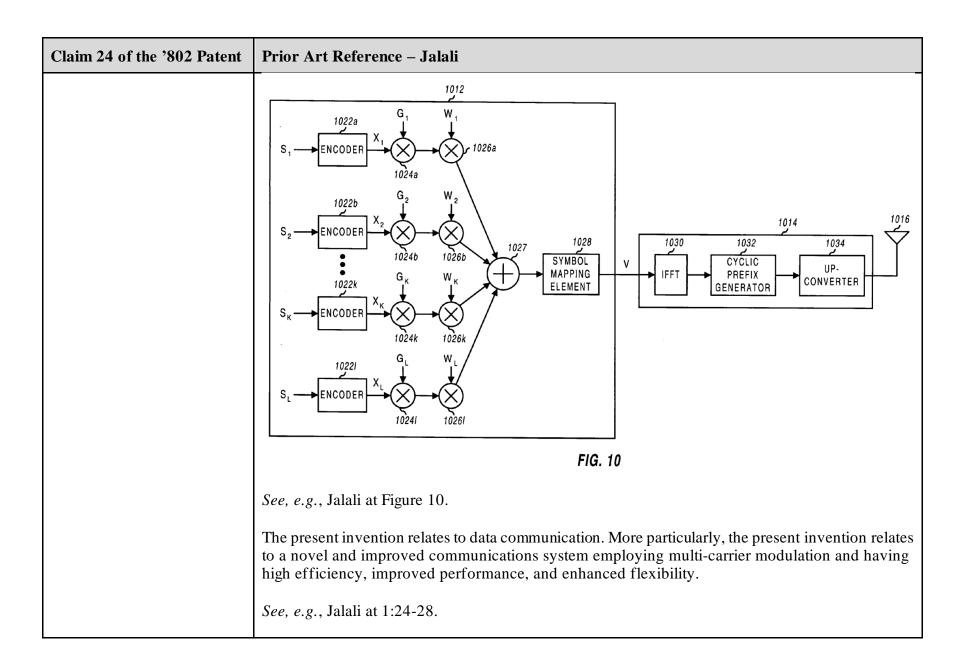
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.3] a second down- converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a	Jalali discloses "a second down-converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-converted signal on the second down-converter output, wherein the first up-converted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency." See, e.g.:
second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

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converted signal on the second down-converter output, wherein the first upconverted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency; and	The modulator transmission. "circuits". Eac symbols, a nu symbols, or so	r modulate The data: the circuit mber of tome other	es the mo from eac can be d ones from combina	odulations  the coded of  efined to  mean a single  ation of to	symbol v lata stre include OFDM ones. Th	vectors to am is may a number symbol, e circuits	provide pped to a r of tones all tones can hav	a modula respecti s from a from on re equal s	ated sign ive set on number e or mon size or di	of OFDM re OFDM
	See, e.g., Jalal	li at Abstr	act.							
	Frequency			OFDM symbol ◀	•					
	sub-channel 1	· 1000 1000 1000 1000 1000 1000 1000 10	control -							<b></b>
	sub-channel 2 sub-channel 3		voice 1 —							-
	sub-channel 4		voice 2 —							-
	sub-channel 5	A 198				voice 3 —				
	sub-channel 6							voice 4 -		-
	sub-channel 7	- 4		A AL	1 1 A 1					37 [2]
	sub-channel 8 sub-channel 9	78 59 2 JA			1.1.364					
	sub-channel 10	1 72 5 7								
	sub-channel 11	可與心學		THE P	a kwat					data 5
	sub-channel 12	Mar YA		al di d	11 A 169					
	sub-channel 13			10 1 1	ři.					
	sub-channel 14 sub-channel 15			## PF#						
	sub-channel 16	pilot	// data 1	data 2	data 2	data 2	data 3	data 1	data 4	data 6
	oub onamer to	<u></u>	////	A second		Z W. Common vocas marchy march	***************************************	×4////////////////////////////////////	//	Time
		ts 1	ts 2	ts 3	ts 4	ts 5	ts 6	ts 7	ts 8	ts 9
					FI	G. 2				
	See, e.g., Jalal	li at Figur	e 2.							





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

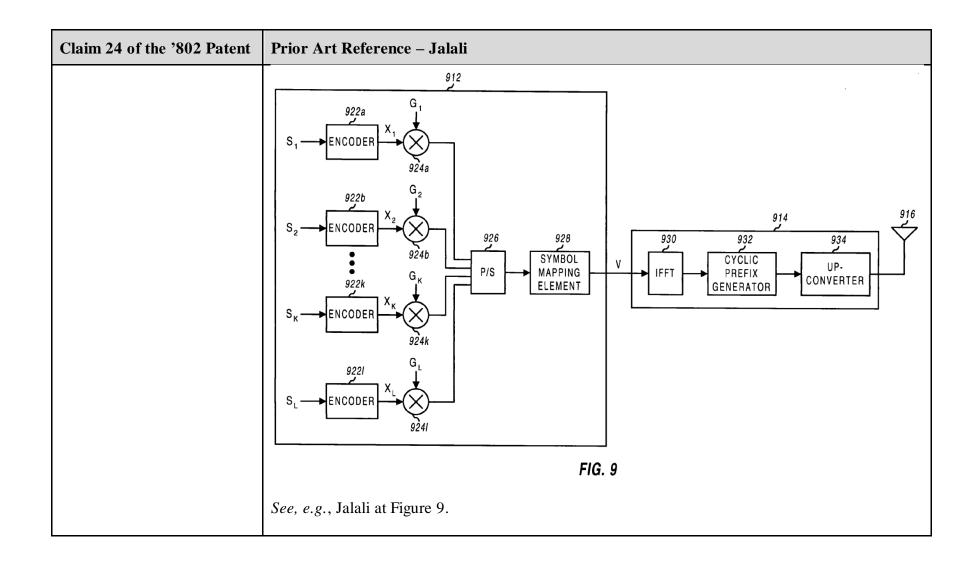
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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

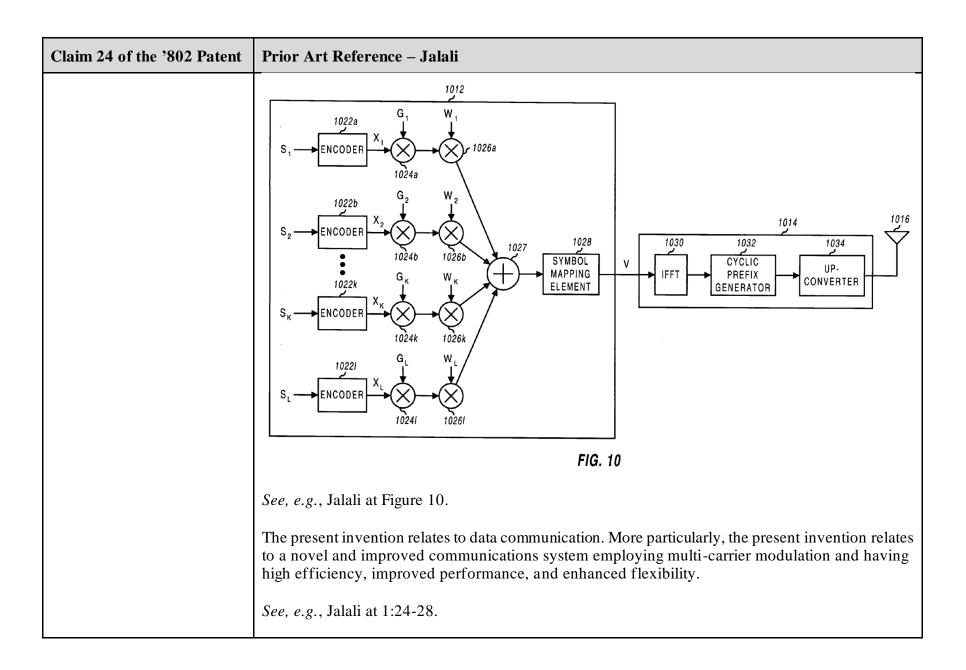
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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.4] a filter having an input coupled to the output of the first down-converter and the	Jalali discloses "a filter having an input coupled to the output of the first down-converter and the output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals." See, e.g.:
output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods).  See, e.g., Jalali at Abstract.
	OFDM symbol ◀
	sub-channel 1 ★ Fig. 3 Control →
	sub-channel 2 broadcast
	sub-channel 3 voice 1
	sub-channel 4 voice 2
	sub-channel 5
	sub-channel 6 sub-channel 7
	sub-channel 8
	sub-channel 9
	sub-channel 10
	sub-channel 11 data 5
	sub-channel 12
	sub-channel 13
	sub-channel 14
	sub-channel 15 sub-channel 16 pilot 4 data 1 data 2 data 2 data 3 data 1 data 4 data 6
	Sub-Chairmen 10
	ts 1 ts 2 ts 3 ts 4 ts 5 ts 6 ts 7 ts 8 ts 9 Time
	FIG. 2
	See, e.g., Jalali at Figure 2.





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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below.
	The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below.
	In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving.
	For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference.
	The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements.
	See, e.g., Jalali at 8:47-9:38.
	FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval).
	The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link.
	See, e.g., Jalali at 13:49-14:11.
	In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time.
	Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space.
	A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data.
	Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one subchannel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency.
	See, e.g., Jalali at 15:26-16:3.
	The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference.
	See, e.g., Jalali at 16:35-47.
	FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914.
	Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916.
	In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams.
	See, e.g., Jalali at 26:55-27:42.
	FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream.
	The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 10261, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014.
	Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016.
	See, e.g., Jalali at 31:48-32:14.
	For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data.
	See, e.g., Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof.
	See, e.g., Jalali at 33:41-54.
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.